CALIFORNIA INDUSTRIAL ENERGY EFFICIENCY MARKET CHARACTERIZATION STUDY

Final Report

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EXECUTIVE SUMMARY

E.1 INTRODUCTION

The industrial sector is difficult to characterize and study because the facilities and the industries differ widely from one another. This also makes it harder to design properly targeted programs for the industrial sector. Further complicating the design of industrial programs is the fact that studies of the nonresidential market and programs also include commercial and agricultural customers, often making it difficult to identify trends specifically germane to the industrial sector and/or whether the programs are meeting the special needs of industrial customers.

The purpose of this study was to cull out information relevant to the industrial sector customers from the wealth of nonresidential information currently available to serve as input in the design of future industrial sector energy-efficiency efforts.

E.2 METHODOLOGY

Figure E-1 presents an overview of the study methodology, showing project data sources, the data elements garnered from each source, and the flow of analysis.

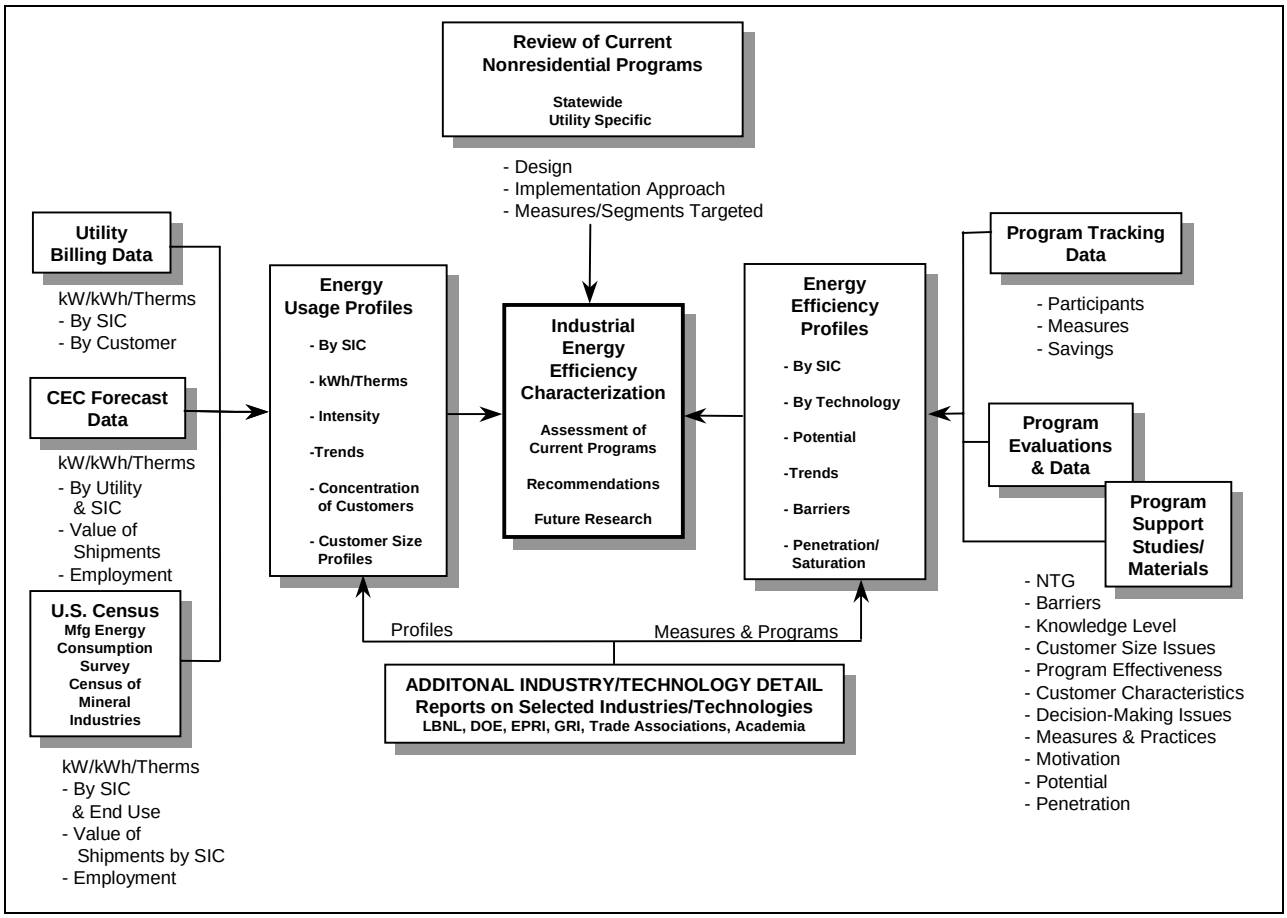
Major sources of energy usage data are shown on the left-hand side of the figure. These sources (mostly in electronic format) were analyzed to provide an energy usage profile for the industrial sector.

On the right-hand side of the figure, key sources of energy-efficiency program information are shown. These data/information sources were utilized to provide an understanding of program effects on the implementation of energy-efficiency measures and practices in the industrial sector. Factors influencing customer decision-making and motivation to install energy-efficiency measures were gleaned from these data.

On the bottom of the figure, the supplemental sources of data are listed. These sources provide additional detail on industrial energy usage characteristics and on available energy-efficiency technologies. Some sources focus on particular industries (such as the pulp and paper industry) and some sources focus on particular end uses or technologies (such as motors or compressed air systems). While many of these studies/sources are more national in focus, the information contained still provides significant, first-level insights into California's industrial market.

These three information groups provide a good, initial characterization of the industrial sector in terms of energy use and energy efficiency. Significant areas of energy-efficiency opportunities (technologies and market segments) are highlighted using these data.

Figure E-1
Methodology Overview



The fourth information area outlined in Figure E-1 relates to a review of current California energy-efficiency programs that target the industrial sector. This review provides an understanding of program design, implementation approaches, market barriers the programs address, and targeted sectors and technologies.

Finally, the information developed in the program analysis is reviewed in light of the industrial market attributes developed in the characterization analysis. The fit between current programs and current opportunities and barriers is assessed. Recommendations are made regarding future programs and areas (sectors and technologies) that should be targeted for additional studies.

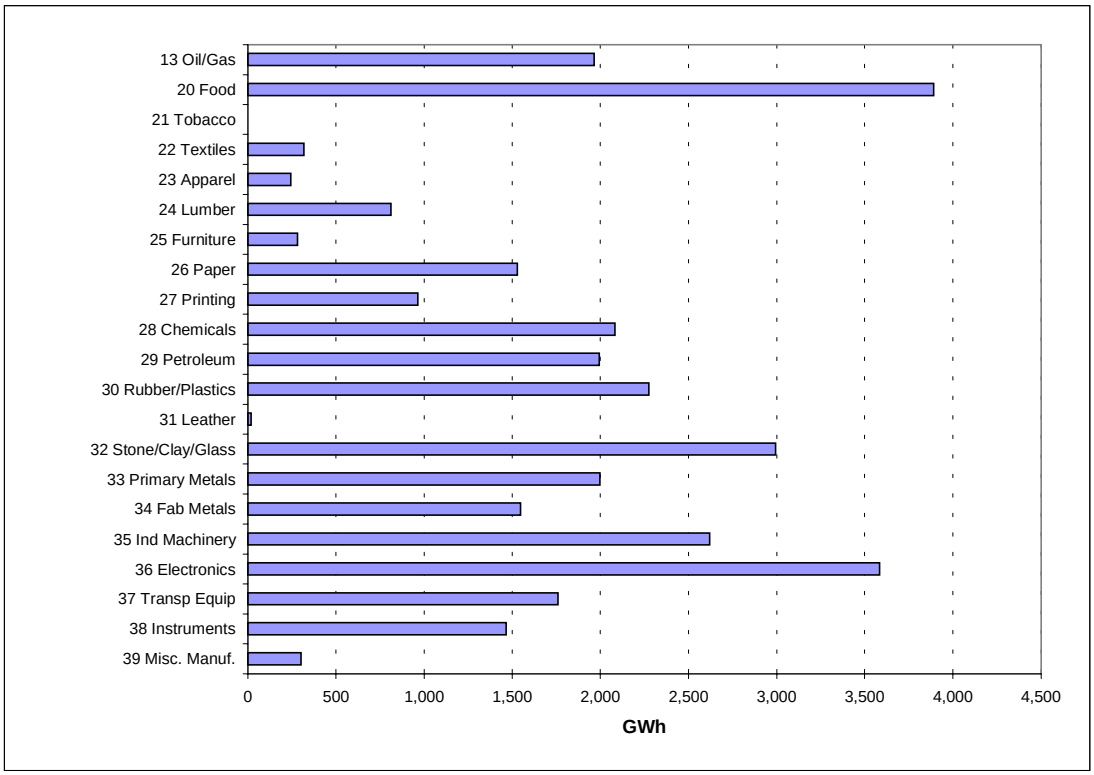
E.3 RESULTS – ENERGY USAGE

E.3.1 Energy Usage by Industrial Group

Electric energy consumption for the major California utilities is shown for key industrial Standard Industrial Classification (SIC) groups in Figure E-2. The largest four industries (20 Food, 36 Electronics, 32 Stone, Clay and Glass, and 35 Industrial Machinery) consumed over 2,500 GWh each. Together, these industries account for about 40% of industrial electric usage.

The next five largest SIC codes (30 Rubber and Plastics, 28 Chemicals, 33 Primary Metals, 29 Petroleum Refining, and 13 Oil and Gas Extraction) all consume about 2,000 GWh per year, accounting for another 30% of industrial consumption.

Figure E-2
Electric Consumption by 2-Digit SIC Grouping

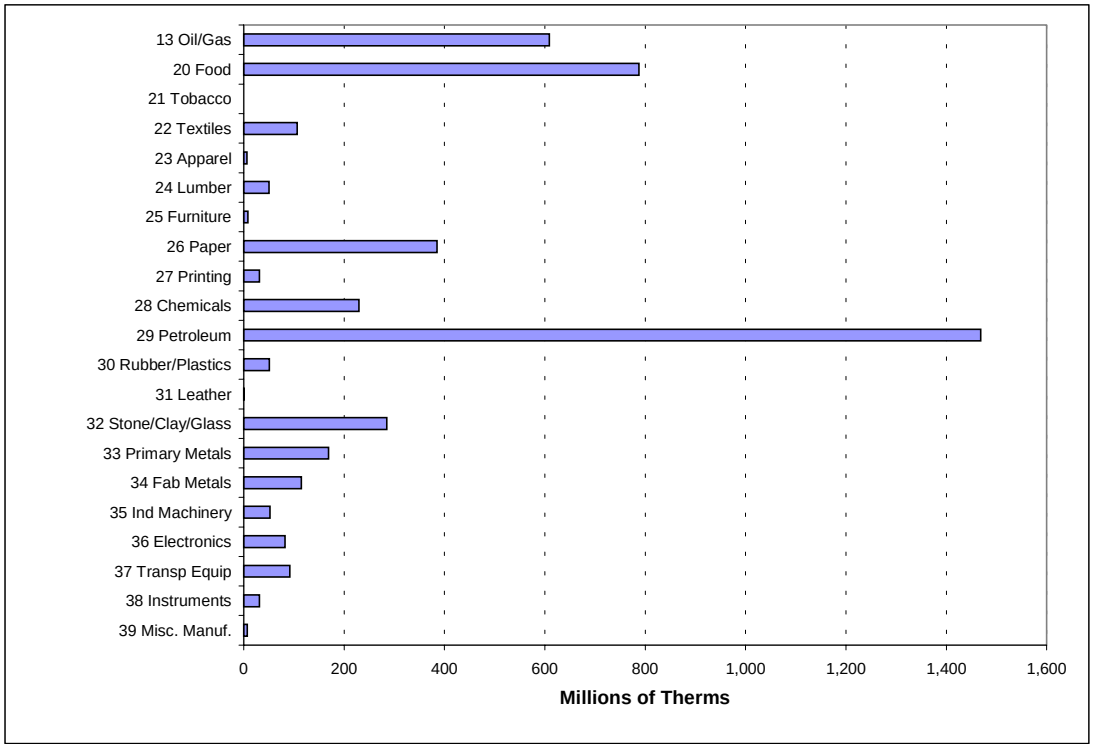


Source: Utility Billing Data

Natural gas consumption figures are shown in Figure E-3. Petroleum refining (SIC 29) is by far the largest consumer of natural gas. The next five largest consuming industries (20 Food, 13 Oil and Gas, 26 Paper, 32 Stone, Clay, and Glass, and 28 Chemicals) all use over 200 million therms per year each. These six industries account for over 80% of industrial gas consumption.

Using CEC forecast data, *projected* growth rates were calculated for the 2000 to 2005 period. The industries (of larger size) with the fastest growing electric usage include Lumber (SIC 24), Chemicals (SIC 28), Rubber and Plastics (SIC 30), Electronics (SIC 36), Transportation Equipment (SIC 37), and Instruments (SIC 38). These industries show annual electric growth rates ranging from 2.5% to 4.5%. The industries with the fastest growing gas usage tend to be smaller gas-consuming industries (24 Lumber, 27 Printing and Publishing, 30 Rubber and Plastics, 36 Electronics, 37 Transportation Equipment, and 38 Instruments). The largest natural gas consuming industries (13 Oil/Gas, 20 Food, 29 Petroleum, and 32 Stone, Clay, and Glass) show annual gas growth rates in the 2% to 3.5% range.

Figure E-3
Natural Gas Consumption by 2-Digit SIC Grouping



Source: Utility Billing Data

E.3.2 Energy Usage by Customer Size

Energy use in the industrial sector is dominated by large customers. Table E-1 shows the size breakdown of sites in the California industrial sector. For electricity, large sites with electric demand of 500 kW or more account for about 6% of the sites, 74% of the kWh consumption, and 74% of the kW demand. The largest 1,000 electric sites account for about two-thirds of total industrial electric consumption. The smallest industrial customers, with demand less than 100 kW, comprise over 80% of all industrial sites but account for less than 11% of industrial electricity consumption. For natural gas, the largest 4% of sites, categorized as large non-core customers, account for about 94% of the natural gas use. The top 100 gas sites account for about two-thirds of total industrial natural gas consumption.

Table E-1
Small-Large Site Breakdown

	Electric			Natural Gas	
	Sites	GWh	MW	Sites	Millions of Therms
Small / Medium	42,559	8,353	1,928	30,662	282
Large	2,646	24,293	5,356	1,322	4,286
% Large	6%	74%	74%	4%	94%

Large electric customers are defined as using more than 500 kW.
Large natural gas customers defined as using more than 250,000 therms per year.
Source: Utility Billing Data

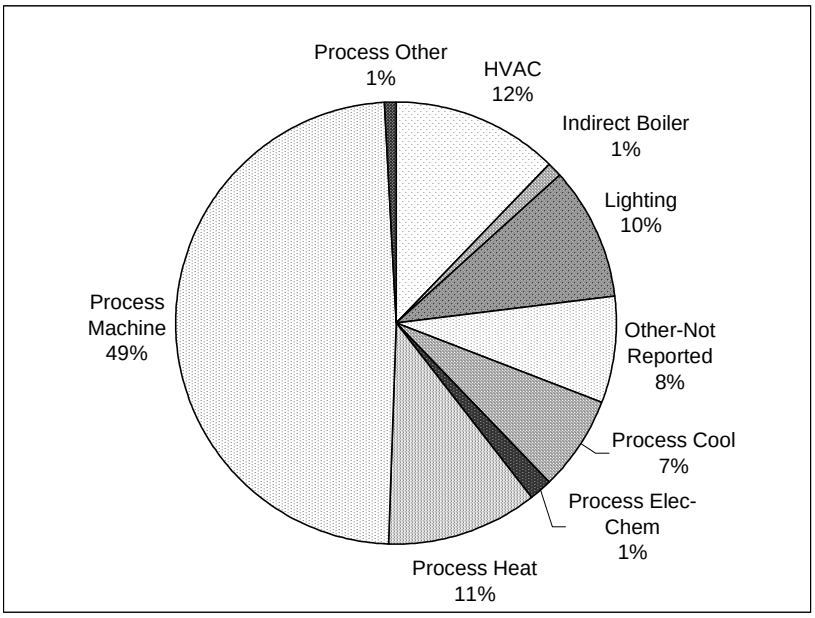
E.3.3 End Use Energy Consumption

For the manufacturing industries (SICs 20-39), end-use energy consumption estimates are available from the Manufacturing Energy Consumption Survey (MECS). MECS is the Energy Information Administration's (EIA's) survey of energy use and related activities by U.S. manufacturers. MECS provides end-use split estimates for all 2-digit manufacturing SIC codes and for selected 3-digit and 4-digit SIC codes. The most recent MECS data, reflecting consumption in 1998 are now being provided using NAICS, the North American Industrial Classification System. These data were available too late to be included in this study. Instead, data from the 1994 MECS are utilized.

To develop California-specific end-use estimates, the MECS end-use splits were applied to California billing data consumption, first at the 4-digit SIC level where MECS 4-digit splits were available, then at the 3-digit level and then the 2-digit level for consumption in remaining 3-digit and 4-digit SICs not directly covered in the MECS. For example, in SIC 29 – Petroleum and Coal Products, the MECS data contain end-use energy estimates for all of SIC 29 and for SIC 2911 (Petroleum Refining). The MECS end-use splits for SIC 2911 were first applied to the California billing data for SIC 2911. Then the MECS end-use splits for SIC 29 minus SIC 2911 were applied to the remainder of the SIC 29 billing data.

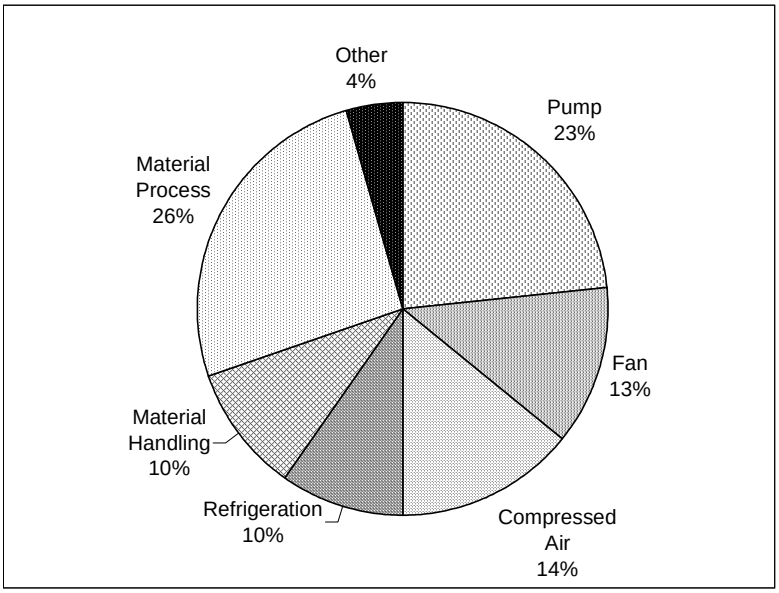
Figure E-4 shows the breakdown of electric usage by key end use. The process machine drive component comprises just about half of the electricity consumption in manufacturing and about 70% of process electricity use. The other largest process end uses are process heating (11% of consumption) and process cooling (7% of consumption). Facility lighting and HVAC usage account for just over 20% of manufacturing electricity use, about evenly split between the two.

Figure E-4
Manufacturing End-use Breakdown of Electric Consumption



A more disaggregate motor breakdown is obtained by combining data on the estimated end-use splits with a motor application breakdown from the DOE Industrial Motor Systems Assessment Study. Figure E-5 shows the results. Pumping and material process applications are the largest electric using applications, accounting for about half of the motor load. Pumps are used to move a variety of materials, including water, fuels, chemical solutions, and oils. Materials process applications include cutting, grinding, shredding, mixing, and materials joining and separation. Other noted applications are split fairly evenly at between 10% and 15% each. Materials handling includes transportation of materials on conveyor belts and positioning of materials in various stages of processing. Fans (excluding HVAC fans) are used mainly in process heating and cooling applications and for the removal of exhaust gasses. Compressed air is commonly used to operate equipment, position pneumatic and hydraulic devices, and pressurize, atomize, and agitate liquids.

Figure E-5
Breakout of Motor Consumption by Application

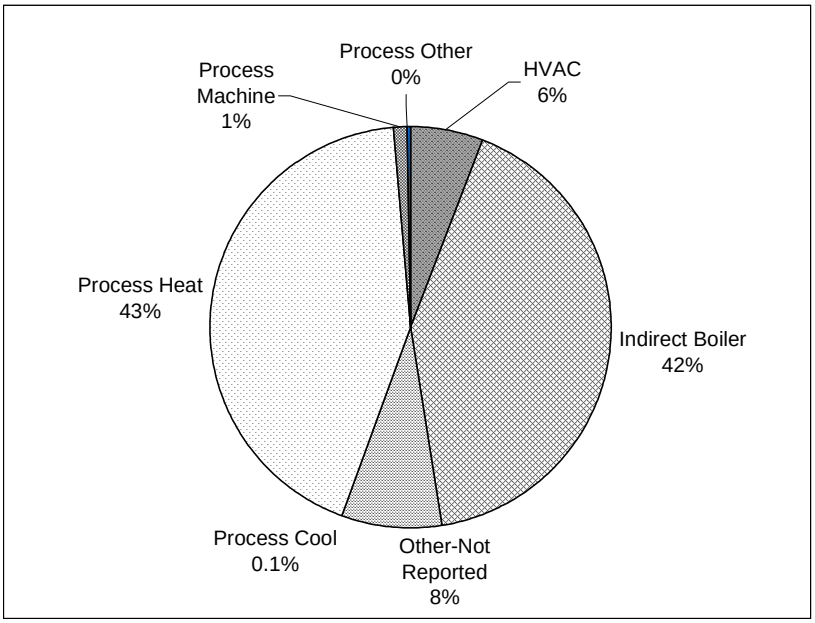


Electric process heating provides some advantages over fossil-fuel-based heating, including improved temperature control, cleaner operations, and reduced maintenance. Techniques include induction, resistance, microwave, and infrared heating. Applications include cooking, melting (metals, glass, plastics), drying and curing (food, lumber, paper, textiles, chemicals, plastics, metals), and direct product heating (metals, chemicals, petroleum, electronics). Process cooling includes refrigeration (food processing) and cooling of materials (chemicals, petroleum products, metals, electronic components) in various stages of the production process.

Figure E-6 presents the breakdown of natural gas usage by key end use. As shown, most of the gas use in manufacturing goes to process heating and indirect boiler fuel (for the production of steam and hot water). As noted above for electricity, key process heating applications include cooking, melting, drying, curing, and materials heating. Boilers are used to produce steam and

hot water that are used in a variety of applications, including cooking, cleaning and sanitation, process heating, concentration and distillation of liquids, and to drive mechanical equipment.

Figure E-6
Manufacturing End-Use Breakdown of Natural Gas Consumption



E.4 RESULTS – ENERGY-EFFICIENCY POTENTIAL

The potential for energy-efficiency savings in the California industrial sector was estimated by first developing savings fractions for key end uses or applications, based on a review of available studies. The savings fractions were then applied to the end use consumption estimates developed above. The objective of the analysis was to identify energy savings estimates that were realistically and cost-effectively achievable using currently available technologies. While not always explicitly noted in each reviewed study, a payback period of three years or less appeared to be a standard cutoff in determining cost effectiveness of the various measures. Energy-efficiency potential is discussed next by key end use.

E.4.1 Motor Systems

Motor system efficiency potential is summarized in Table E-2. Savings fraction estimates were developed from the DOE Industrial Motor Systems Assessment Study. System-specific measure savings potential is shown at the top of the table, and general motor efficiency measures that apply to all systems are shown at the bottom of the table. System efficiency measures can save up to 9% of motor energy use, with the potential for pump system savings and compressed air system savings of 15% or more of each systems energy use. Applicable motor efficiency measures can save another 5% of total motor energy usage.

Table E-2
Industrial Motor Savings Potential in California

Application / Measure	Energy Use (GWh)	Savings Potential (GWh)	Savings %
Motor System Measures			
Fan System	2,338	118	5%
Pump System	4,237	803	19%
Compressed Air Systems	2,703	461	17%
Other Process Systems	7,808	154	2%
All Systems	17,086	1,535	9%
Motor Efficiency Measures (Apply to All Systems)			
Efficiency Upgrades	17,086	581	3%
Motor Downsizing	17,086	205	1%
Replace vs. Rewind	17,086	142	1%
All Motor Efficiency Measures	17,086	928	5%
Motor Systems Totals	**17,086**	**2,463**	**14%**

Key fan system measures include: improved inlet and outlet design, reduction of fan oversizing, installation of adjustable-speed drives (ASDs), replacement of standard V-belts with cogged V-belts, installation of more efficient fan models, and improved O&M practices (such as tightening belts and cleaning fans).

Pump system measures include: utilizing holding tanks to equalize flow over the production cycle, eliminating bypass loops, increasing piping diameter, reducing system capacity safety margins, matching pump size to loads, installing parallel systems for variable loads, reducing pump speeds for fixed loads, installation of ASDs for variable loads, installation of more efficient pumps, replacement of belt drives with direct couplings, and improved O&M practices (such as replacing worn impellers and maintaining bearings and seals).

Compressed air system measures include: reducing system pressure through better design, eliminating poor applications for compressed air (such as blowing, cooling, and cleaning), segmenting systems with remote applications and special requirements (such as higher pressure), sizing compressors correctly, installing standard part-load controls, using parallel compressors and controls to reduce part loading, installing ASDs, replacing older compressors with more efficient models, and instituting an ongoing maintenance plan to: identify and reduce leaks, change filters, and service compressor components.

E.4.2 Lighting

Electric savings potential for the lighting end use is outlined in Table E-3. The lighting energy breakdown by fixture type was developed from an industry survey conducted for SCE in 1997, with judgmental assumptions made to adjust the data to current-period shares. Savings percentages were developed assuming: (1) incandescent lighting is converted to compact fluorescent, (2) standard fluorescent lighting is converted to T8s with electronic ballast, and (3)

mercury vapor lighting is converted to high-pressure sodium. Available data did not support the assessment of lighting control measures or day lighting.

Table E-3
Lighting Energy Savings Potential

Fixture Type	% Lighting Energy	Savings %	GWh Savings
Incandescent	5	72	99
Std Fluorescent / Std Ballast	58	24	421
Std Fluorescent / EE Magnetic Ballast	13	14	53
T8 / Electronic Ballast	14	-	-
Mercury Vapor	2	35	21
Metal Halide	4	-	-
High Pressure Sodium	2	-	-
Low Pressure Sodium	negligible	-	-
Skylights	2	-	-
Other	negligible	-	-
Total Lighting Savings Potential		**20**	**594**

Total Lighting Energy = 2,997 GWh

E.4.3 Space Cooling

Cooling energy savings potential estimates are summarized in Table E-4. Total HVAC energy use, developed using MECS data and utility billing data, were converted to cooling energy use using additional industrial survey data from the 1997 SCE industrial survey. The cooling savings percent was based on overall estimates developed from commercial energy-efficiency potential studies. There were not sufficient data available to provide additional detail on industrial cooling savings. The commercial cooling studies addressed measures such as high-efficiency DX systems, high-efficiency chillers, economizers, evaporative pre-coolers, energy management systems, and cooling system maintenance.

Table E-4
Cooling Energy Savings Potential

HVAC electric use	3,754 GWh
Cooling fraction	58%
Cooling electric use	2,161 GWh
Cooling savings percent	24%
Total Cooling Savings Potential	**519 GWh**

E.4.4 Indirect Boiler Use

For California, natural gas use in indirect boilers is estimated to be about 1,649 million therms a year (based on analysis of MECS and utility billing data). The U.S. DOE – Alliance to Save Energy Steam Challenge program estimates that optimization of industrial steam systems can save 30-40% of steam system energy use through the introduction of their BestPractice approach

(sponsored by the U.S. DOE OIT), which focuses on system improvements and controls. Their target is for 20% efficiency improvements by 2010. A similar estimate of economically achievable savings in the 18-20% was developed by Lawrence Berkeley National Laboratory (LBNL 2001). At 20%, potential energy savings for the boiler end use are about 330 million therms per year. Table E-5 highlights some key steam system efficiency measures.

Table E-5
Steam System Efficiency Measures

Measures	Savings Potential
Boilers	**2-5%**
Boiler tune-ups	1-2%
Heat recovery equipment	2-4%
Emissions monitoring and control	1-2%
System Operation and Maintenance	**10-15%**
Water control	10-12%
Load control	3-5%
Distribution System	**15-20%**
Steam leaks and traps	3-5%
Condensate return	10-15%
Insulation	5-10%
Total	**30-40%**

Source: DOE-Alliance, 2000

E.4.5 Process Heat

The U.S. Industrial Combustion Vision facilitated by the U.S. DOE, targets energy-efficiency improvements of 20-50% by the year 2020. However, the vision acknowledges that large efficiency improvements will require technology improvements in furnace design, sensors and controls, and heat recovery processes that are beyond current efficiency capabilities. Savings that are economically attainable with current technologies are lower.

Table E-6 lists key process heating measures and estimates of their potential savings using current technologies. Increased insulation, utilizing newer, better-insulating materials, may provide that largest impacts. Improved combustion using more advanced control strategies provides the next largest area for savings. The savings potential for waste heat recovery is less than is cited for boilers since direct-fired heating units mainly use air preheaters as their only form of waste heat recovery. By applying a conservative 8% savings potential estimate to the California process heat gas use estimate of 1,700 million therms per year (developed by combining MECS and utility billing data), an estimate of potential energy savings of 136 million therms per year is obtained. Note, a number of energy saving measures, such as elimination of heat transfer equipment in drying and the use of electro-technologies, are applicable to process heating systems. However, energy savings estimates could not be developed from the available information.

Table E-6
Process Heating Efficiency Measures

Measures	Savings Potential
Improved Refractory (Insulation)	5-10%
Combustion Controls/Sensors	3-5%
Reduction of Excess O_2	2-3%
Waste Heat Recovery	1-3%
Total	**10-15%**

E.4.6 Industry Specific Measures

There are a large number of industry-specific energy-efficiency measures that can be applied to particular industrial processes. However, due to the high variability and limited applicability of these measures, it was not possible to quantify potential impacts on California industrial energy use. Examples of such measures include: electron beam sterilization in the food industry, application of liquid membrane technologies in the chemicals industry, black liquor gasification in the pulp and paper industry, ultrasonic drying in the textiles industry, biodesulfurization in the petroleum refining industry, and strip casting in the metals industry. In addition, introduction of computerized controls and sensors can be used to reduce waste in many different production processes. Additional information on the applicability and cost-effectiveness of many industry-specific measures is available from sources such as the Lawrence Berkeley National Laboratories (www.lbl.gov) and the U.S. DOE Office of Industrial Technologies (www.oit.doe.gov).

E.4.7 Energy-efficiency Potential Summary

Table E-7 summarizes industrial energy-efficiency potential by measure and industry. For electric savings potential, measures targeting motor systems account for about two-thirds of the overall savings potential, with lighting and space cooling measures splitting the remaining potential about evenly. Key industries, with about 300 GWh or more of savings potential each, include Food (SIC 20), Petroleum Refining (SIC 29), Stone, Clay and Glass (SIC 32), Industrial Machinery (SIC 35), and Electronics (SIC 36). Key industries with large natural gas savings potential include Food (SIC 20), Paper (SIC 26), and Petroleum Refining (SIC 29).

Table E-7
Summary of Energy-efficiency Savings Potential

Industry Category	Electric Potential - GWh					Gas Potential - Mth			
	Motors	Lighting	Space Cooling	Total Electric	% of Industry Total	Boilers	Process Heat	Total Gas	% of Industry Total
20 Food	320	54	44	374	12%	101	13	114	25%
21 Tobacco			-	0	0%	0	0	0	0%
22 Textiles	28	6	5	34	1%	13	2	16	3%
23 Apparel	14	8	14	22	1%	0	0	1	0%
24 Lumber	84	12	9	96	3%	4	2	6	1%
25 Furniture	21	9	9	30	1%	0	0	1	0%
26 Paper	148	21	24	169	6%	54	5	59	13%
27 Printing	74	23	42	97	3%	1	1	2	0%
28 Chemicals	222	24	9	245	8%	24	5	30	6%
29 Petroleum	338	11	9	349	11%	95	66	161	34%
30 Rubber/Plastics	175	29	18	204	7%	4	1	5	1%
31 Leather	1		-	1	0%	0	0	0	0%
32 Stone/Clay/Glass	312	38	21	350	11%	3	19	22	5%
33 Primary Metals	112	21	13	133	4%	4	10	14	3%
34 Fab Metals	122	35	35	156	5%	4	5	9	2%
35 Ind Machinery	154	85	57	239	8%	4	1	5	1%
36 Electronics	160	88	91	248	8%	6	3	8	2%
37 Transp Equip	88	67	85	155	5%	7	2	9	2%
38 Instruments	75	54	24	129	4%	3	0	4	1%
39 Misc. Manuf.	15	9	12	25	1%	0	0	1	0%
Total	**2,463**	**594**	**519**	**3,057**	**100%**	**330**	**136**	**466**	**100%**

E.5 RESULTS – REVIEW OF UTILITY PROGRAM INFORMATION

Utility program information reviewed during this study included program tracking data and program evaluation data and reports.

E.5.1 Program Tracking Data

Utility energy-efficiency program tracking data was reviewed for the years 1995 through 1999. The review focused mainly on rebate programs (utility rebate programs, third-party rebate programs, and standard performance contracting programs). Table E-8 summarizes program activity by industrial group and key end use (data resolution did not permit a good disaggregation of program impacts by measure). Process measures accounted for the largest amount of impacts (61% of electric impacts and 97% of natural gas impacts), followed by lighting and HVAC.

Table E-8
Industrial Rebate Program Accomplishments 1995-1999
(Tracking System Gross Savings)

Industry Category	# Part-icipants	Electricity Impacts (GWh)				Gas Impacts (Mth)		
		Process	Lighting	HVAC	Total	HVAC	Process	Total
13 Oil/Gas	66	78.5	0.1	0.1	78.7	-	9.9	9.9
20 Food	424	55.7	9.1	10.4	75.1	-	5.0	5.0
21 Tobacco	-	-	-	-	-	-	-	-
22 Textiles	37	1.4	3.4	0.1	4.8	-	0.7	0.7
23 Apparel	17	-	0.8	0.1	0.8	-	0.1	0.1
24 Lumber	127	26.4	6.5	-	32.9	-	0.5	0.5
25 Furniture	38	0.3	3.2	-	3.4	-	0.1	0.1
26 Paper	89	32.7	6.4	0.8	39.9	-	0.4	0.4
27 Printing	208	10.4	9.4	9.1	28.9	0.1	-	0.1
28 Chemicals	135	21.2	2.2	3.4	26.7	0.1	3.3	3.4
29 Petroleum	37	1.0	2.2	6.3	18.5	0.4	6.6	7.1
30 Rubber/Plastics	172	29.1	6.0	3.3	38.3	-	0.1	0.1
31 Leather	10	0.9	0.2	-	1.1	-	0.2	0.2
32 Stone/Clay/Glass	91	46.2	7.1	-	53.3	-	2.3	2.3
33 Primary Metals	94	16.6	5.9	1.3	23.7	-	0.8	0.8
34 Fab Metals	237	10.1	6.9	0.3	17.4	-	2.4	2.4
35 Ind Machinery	357	18.1	22.8	14.3	55.3	-	0.1	0.1
36 Electronics	326	17.1	20.5	28.3	65.9	0.1	0.3	0.5
37 Transp Equip	154	50.1	39.8	12.9	102.8	0.3	0.7	1.0
38 Instruments	183	7.0	18.4	12.1	37.5	-	-	-
39 Misc. Manuf.	66	6.0	0.9	0.5	7.4	-	-	-
Total	**2,868**	**437.7**	**171.5**	**103.2**	**712.4**	**1.0**	**33.5**	**34.5**

Key industries contributing to electric impacts included Transportation Equipment (SIC 37), Food (SIC 20), Oil and Gas Extraction (SIC 13), Electronics (SIC 36), Industrial Machinery (SIC 35), and Stone, Clay, and Glass (SIC 32). Each industry accounted for over 50 GWh of impacts. For natural gas, key industrial include Oil and Gas Extraction (SIC 13), Petroleum Refining (SIC 29), Food (SIC 20), and Chemicals (SIC 28), each accounting for over 3 million therms of savings.

Although measure-specific detail was hard to assess due to differences in classifications between utilities and limited resolution, some information on specific measure types could be addressed. Key HVAC measures included chillers, ASDs, and energy management systems. These accounted for about two-thirds of electric HVAC impacts. For lighting, T8's accounted for 60% of program impacts and high-intensity discharge (HID) lighting accounted for 15% of impacts. Remaining lighting measures were predominantly controls. Key electric process measures included compressed air system improvements, ASDs, pumps, motors, and process heating. Key natural gas process measures included boilers, process heating improvements, and measures involving gas-driven oil pumping systems.

A comparison of the program accomplishments in Table E-8 with identified energy-efficiency potential in Table E-7 is provided in Table E-9. Results show that past rebate programs have

been more effective at targeting electricity-saving measures than gas-saving measures. Clearly, electricity savings have been a focus of the rebate programs in California. The ratio of electric tracking savings to identified potential is about 0.18, whereas the ratio of gas savings to gas potential is only 0.05 (with both ratios excluding impacts in the oil and gas extraction industry). For electricity, lighting measures have had the biggest penetration; the ratio of impacts to potential is about 0.30. In general, program accomplishments have been relatively well dispersed across the different industrial groups. (Note that the impact-to-potential ratios don't exactly correspond to the fraction of savings potential captured by the rebate programs because of definitional issues; i.e., program impacts are more heavily weighted to equipment-related savings while the potential analysis focuses more on implementation of lower cost maintenance and control measures. However, the ratios do help provide a good indication of whether program activity has been targeting the key energy consuming end uses.)

Table E-9
Comparison of Energy Savings Potential and Program Accomplishments

	Electric - GWh				Gas - Mth		
	Process	Lighting	Space Cooling	Total Electric	HVAC	Process	Total Gas
Energy Savings Potential (Table E-7)	2,463	594	519	3,576	-	466	466
Program Impacts, 95-99 (Table E-8)*	359	171	103	634	1	24	25
Ratio: Impacts to Potential	0.15	0.29	0.20	0.18	-	0.07	0.05

* To be comparable to potential estimates, program impacts exclude SIC 13, Oil/Gas Extraction.

Utility programs have done reasonably well in targeting the appropriate end uses for industrial energy efficiency; however, they seem to have excluded promotion of key measure areas:

- Utility programs have focused mainly on the purchase and installation of new, energy-efficient equipment, mostly through the use of rebate programs.

While,

- Review of the literature on energy savings potential reveals that considerable savings can be obtained by making "systems" more efficient, often through the use of improved operation and maintenance practices, improved system design, and the installation of control measures. The types of measures discussed in the literature are not easily promoted through traditional rebates-for-equipment programs.

In many cases, industrial customers are not aware of the types of measures that can be instituted to achieve energy savings or the magnitude of savings that can be achieved through the implementation of systems solutions.

Thus,

- Programs that seek to inform customers on their energy-efficiency potentials, options, and associated benefits/costs and connect them to contractors and financing, providing turnkey projects, are likely to garner significant cost-effective energy savings that are missed by traditional incentive-only programs.

E.5.2 Program Evaluation Information

Program evaluation information developed since the mid 1990s was reviewed to assess a number of factors such as net-to-gross, barriers to energy-efficiency installations, and customer needs and wants. Key results are summarized below.

Net-to-Gross Ratios. Program impact evaluations were reviewed for the 1995 through 1999 period. A key element that was developed from the review was an examination of net-to-gross ratios. Table E-10 shows net-to-gross ratios by end use and Table E-11 shows net-to-gross ratios by industrial group. In each case, the net-to-gross ratios are energy-savings weighted averages of all the evaluated industrial projects. Overall, industrial net-to-gross ratios averaged about 0.70. Motor efficiency measures tended to achieve the highest net-to-gross ratios, while process and HVAC measures were associated with the lowest ratios. The food, lumber, printing, rubber and plastics, and stone, clay, and glass industries were associated with the lowest net-to-gross rations of 0.63 or lower. The paper, petroleum, instruments, and electronics industries averaged net-to-gross ratios above 0.75.

Table E-10
Net-to-Gross Ratios by End Use

End Use	Net-to-Gross Ratio	Number of Observations
HVAC	0.67	310
Lighting	0.72	1,152
Miscellaneous	0.72	10
Motors	0.84	190
Process	0.70	425

Source: Impact evaluations of California's industrial energy-efficiency programs.
Net-to-gross ratios are avoided-cost weighted averages of project-level ratios.

Overall, industrial net-to-gross ratios tend to fall below net-to-gross ratios for other customer segments. For the same period of analysis (the second half of the 1990's), commercial sector programs averaged net-to-gross ratios of 0.89 and residential programs had net-to-gross ratios of 0.81. It appears that, compared to other segments, more industrial customers were likely to have implemented energy-efficiency measures anyway, without the incentives provided by the California utilities. Note, recent research has indicated that the net-to-gross method used to evaluation industrial projects, the self report method, may be biased downwards relative to other statistical net-to-gross methods used more frequently in residential and commercial studies (Ridge and Associates, October 2001).

Table E-11
Net-to-Gross Ratios by Industrial Group

Industry Category	Net-to-Gross Ratio	Number of Observations
13 Oil/Gas	0.68	53
20 Food	0.63	228
21 Tobacco	-	-
22 Textiles	0.54	14
23 Apparel	1.00	8
24 Lumber	0.41	83
25 Furniture	0.66	18
26 Paper	0.90	88
27 Printing	0.54	169
28 Chemicals	0.71	89
29 Petroleum	0.85	52
30 Rubber/Plastics	0.62	120
31 Leather	0.99	6
32 Stone/Clay/Glass	0.63	73
33 Primary Metals	0.65	69
34 Fab Metals	0.70	119
35 Ind Machinery	0.72	263
36 Electronics	0.76	264
37 Transp Equip	0.69	147
38 Instruments	0.77	125
39 Misc. Manuf.	0.81	31

Source: Impact evaluations of California's industrial energy-efficiency programs.
Net-to-gross ratios are avoided-cost weighted averages of project-level ratios.

Barriers to Energy-Efficiency Implementation. Review of more recent evaluations of the California SPC (Standard Performance Contract) programs provides some insight into key barriers to the installation of energy-efficiency measures. Key barriers identified in customer interviews included:

- Costs associated with increasing energy efficiency;
- Uncertainty over projects savings;
- The time it takes to get informed about energy-efficiency opportunities and projects;
- Time and cost associated with selecting contractors for projects; and
- Uncertainty about the savings information provided by energy-efficiency firms.

The SPC evaluations also revealed a number of factors regarding large utility customers:

- Over 90% had taken recent actions to reduce energy use;
- Over 60% had identified energy-efficiency opportunities but had not implemented them, mostly due to cost factors;
- Fewer than 30% of the customers had separate budgets for energy-efficiency projects;
- Most customers had a target payback threshold of 3 years or less for energy-efficiency projects; and
- Local utilities received the highest credibility rating for providing energy-efficiency related information.

Compressed Air Research: Review of recent research undertaken by the California utilities to better understand the compressed air market provides some insight into customer attitudes, opinions, and practices with regard to an industrial "system." It is likely that these findings will also be applicable to other industrial systems such as steam systems and pumping systems. Key findings from the compressed air research include:

- Many customers do not understand key technical aspects of their compressed air system;
- Around two-thirds of the surveyed customers have done nothing to reduce their compressed air system costs; many realize they are missing opportunities but cite lack of time as a key barrier;
- Most customers perform routine maintenance on their compressed air systems, but little performance testing is undertaken; and
- Many customers indicated that they would be interested in a compressed air performance analysis service but weren't sure how valuable it would be or how much they would be willing to pay.

Large Customer Needs and Wants: A large customer needs and wants study, relying mainly on focus-group activities involving industry experts, was recently completed for the California utilities. Key findings from this study, as they pertain to increasing energy-efficiency opportunities, include:

- Industry representatives view utilities as experts on energy-related issues but indicate that the utilities are perceived as failing to understand industry needs;
- There is a strong desire on the part of industry representatives to enter into mutually beneficial partnerships with their utility suppliers;
- Strategic guidance should be provided in executive-level interactions, facilitated by experienced consultants and industry associations and supported by solid background research and analysis;
- Tactical guidance on specific energy-efficiency opportunities should continue to be provided by account representatives, utilizing certain types of expert consultants as necessary;
- Programs should be industry specific and should be promoted as enhancing productivity first, energy efficiency second.

E.6 CONCLUSIONS

Some of the more important conclusions developed from the study are presented briefly below:

- Most energy use, and thus savings potential, is concentrated in the largest sites. The largest 4% of electric sites account for over 70% of the electricity use. The largest 3% of natural gas sites account for over 90% of industrial gas use. For programs to achieve large impacts and optimize the use of public funds, they need to target these large sites.

- Key energy areas of industrial efficiency potential include motors, steam, and process heating systems. In many cases, improving a "system" can provide significant cost-effective savings, sometimes in lieu of purchasing expensive new equipment.
- Industrial energy-efficiency potential appears to remain large relative to the past 5 years of program activity. Natural gas savings potential is still relatively untapped.
- Historically, industrial net-to-gross ratios associated with California rebate programs are lower than those for other customer segments, typically 0.67 to 0.84 versus .81 to .89 in residential and commercial sector programs, respectively (although some of this difference may be due to a downward bias associated with the method used to evaluate industrial projects). However, many industrial customers still cite "lack of capital" as a major barrier to implementing energy-efficiency projects.
- Many customers appear to be uniformed about the costs and benefits of energy-efficiency projects. They often do not have a good understanding of the energy-efficiency aspects of key energy using systems (e.g. compressed air, pumping, steam).
- Mostly, energy-efficiency programs have been component focused, not system focused, where symbioses between components can lead to much higher savings potentials in industrial facilities. This will require careful modification of current programs to broaden the scope of their efforts.
- Industrial customers look to the utilities to provide credible guidance to help them pursue energy-efficiency opportunities.

E.6.1 Implications for Future Program Design

The current array of utility programs that rely predominantly on customer incentives will continue to achieve significant impacts, especially under the current energy environment. However, these programs that tend to favor equipment change-outs will continue to miss opportunities to improve the energy efficiency of industrial systems. Programs that focus on customer education and programs that provide expert facility analyses will most likely be more effective at targeting "system" energy efficiency. Future programs should consider:

- Targeting large customers where large energy savings are likely;
- Utilizing the current network of utility customer representatives to deliver programs to customers;
- Providing site-specific studies of key energy using systems, conducted by industry experts at little or no cost to the customer; these studies should identify key energy-efficiency measures, provide savings estimates, and provide cost effectiveness calculations;
- Providing financial incentives for some of the measures identified in the site studies while leaving the customer to pay for the most cost-effective measures;
- Assisting the customer in implementing the project; and
- Providing unbiased measurement and verification of results for customers to see savings, and instituting energy-efficiency operation and maintenance practices that are more likely to lead to continued energy-efficiency enhancement.

E.6.2 Recommendations for Research Activities

Areas for potential research to better understand industrial energy-efficiency opportunities include:

- Studies to better understand important energy consuming industries such as Oil and Gas Extraction (SIC 13), Food Processing (SIC 20), and Petroleum Refining (SIC 29);
- Studies to better understand important energy consuming systems such as pump systems, steam systems, and process heating systems;
- Research on the market penetration of high-efficiency equipment such as boilers, pumps, fans, compressors, chillers, motors, and control equipment;
- Assessment of the market for expert consultants who could provide high-level audits of industrial systems;
- Additional assessment of small industrial customer needs and wants that could be gleaned from a survey of over 750 nonresidential customers that was conducted during mid-2000 (Quantum, October 2001);
- Research on how to better integrate California's industrial energy-efficiency activities with initiatives being undertaken by the U.S. DOE; and
- Assessment of industrial program activities in other states.

1 INTRODUCTION

This report presents results of research conducted to characterize the current California industrial market with respect to energy usage and energy-efficiency opportunities. The study relies primarily on secondary source data and utility billing data. Energy-efficiency potential in the industrial sector is addressed in the study and is compared to recent program activity. The study focuses on industrial customers of the four major California investor-owned utilities: Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), Southern California Gas Company (SCG), and San Diego Gas and Electric Company (SDG&E).

1.1 STUDY GOALS

The goals, outlined at the beginning of this study, were to use primarily secondary source data to:

- Identify the best opportunities for industrial energy-efficiency improvements and market transformation;
- Assess the extent to which current programs are addressing these opportunities; and
- Provide recommendations for future programs and future research.

The study addressed each of these goals and, in addition, provided a fairly extensive review of electricity and natural gas consumption in the industrial sector.

1.2 INDUSTRIAL SECTOR DEFINITION

For the purposes of this study, the industrial sector is defined as customers whose SIC (Standard Industrial Classification) Codes fall between 10 and 39 (at the 2-digit level). Primary focus is given to the manufacturing sector (SIC codes 20 through 39). Several industry categories are relatively small energy consumers in California and were not addressed in the study; these include SIC codes 10, 11, 12, 14, 15,16, and 17. Table 1-1 lists the different industrial categories, as defined by their 2-digit SIC codes.

1.3 STUDY APPROACH

Using secondary source data from utility, government, academic, and non-governmental organization sources, the research identifies the primary energy-efficiency opportunities among industrial customers, both in terms of key industries (based on SIC code) and key technologies and end uses.

Table 1-1
Industrial SIC Categories and Their Descriptions

SIC	SIC Description
10	Metal mining
12	Coal mining
13	Oil and gas extraction
14	Nonmetallic minerals, except fuels
15	General building contractors
16	Heavy construction contractors
17	Special trade contractors
20	Food and kindred products
21	Tobacco manufactures
22	Textile mill products
23	Apparel and other textile products
24	Lumber and wood products
25	Furniture and fixtures
26	Paper and allied products
27	Printing and publishing
28	Chemicals and allied products
29	Petroleum and coal products
30	Rubber and miscellaneous plastics products
31	Leather and leather products
32	Stone, clay, glass, and concrete products
33	Primary metal industries
34	Fabricated metal products
35	Industrial machinery and equipment
36	Electrical and electronic equipment
37	Transportation equipment
38	Instruments and related products
39	Miscellaneous manufacturing industries

Utility billing data are analyzed to identify important industry groups in terms of electricity and natural gas consumption. These data are combined with end-use consumption information from the U.S. Department of Energy's (DOE's) Manufacturing Energy Consumption Survey (MECS) to provide estimates of end-use energy consumption for SIC codes 20 through 39.

Energy savings potential fractions for key end uses and applications are garnered from various studies, generally reflecting estimates at the national level. These fractions are applied to end-use consumption estimates to estimate California's energy-efficiency savings potential.

Utility program tracking data are analyzed to identify key program areas that have been promoted in prior years and to identify key industries and customer groups that have used the utility programs. Program evaluation data are reviewed to identify significant barriers to the implementation of energy-efficiency measures. Current energy-efficiency program efforts are

compared to the findings of the market characterization, and program recommendations, based on findings, are made. The study also identifies a number of topics for future research.

1.4 REPORT ORGANIZATION

The remainder of this report is organized as follows:

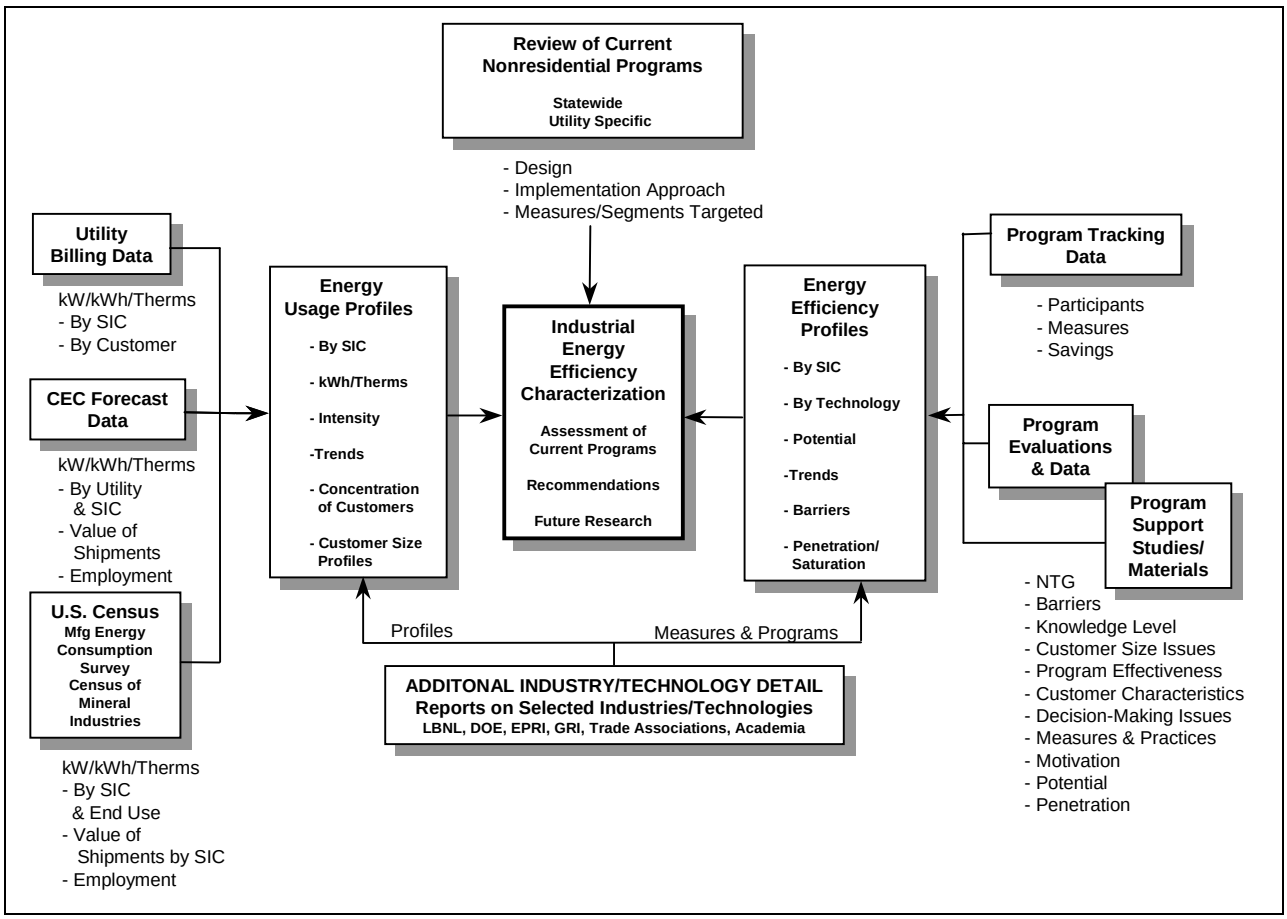
- Section 2: Study Methodology
- Section 3: Energy Usage Characterization Results
- Section 4: Energy-Efficiency Characterization Results
- Section 5: Program Accomplishments and Comparison to Energy-Efficiency Potential
- Section 6: Conclusions and Recommendations
- Section 6: References
- Appendix A: Mapping of Industrial SIC Codes to NAICS (North American Industry Classification System) Codes
- Appendix B: Summary of PY2001 Nonresidential Programs

2 METHODOLOGY

2.1 OVERVIEW

This section describes the data-collection and analysis approach used for this study. An overview of the study methodology is presented in Figure 2-1. This figure identifies key project data sources and analysis elements developed from each data source.

Figure 2-1
Methodology Overview



Major sources of energy usage data are shown on the left-hand side of the figure. These sources (mostly in electronic format) were analyzed to provide an energy usage profile for the industrial sector.

On the right-hand side of the figure, key sources of energy-efficiency program information are shown. These information sources were used to provide an understanding of program effects on the implementation of energy-efficiency measures and practices in the industrial sector. Factors

influencing customer decision-making and motivation to install energy-efficiency measures were also be gleaned from these data.

On the bottom of the figure, the supplemental sources of data are listed. These sources provided additional detail on industrial energy usage characteristics and potential savings from installation of available energy-efficiency technologies. While many of these studies/sources were more national in focus, the information contained in them still provides significant, first-level insights into California's industrial market.

These three information groups provided a good, initial characterization of the industrial sector in terms of energy use and energy efficiency. Significant energy-efficiency opportunities (technologies and market segments) were identified from an analysis of these data.

The fourth information area outlined in Figure 2-1 relates to a review of current and past California energy-efficiency programs influencing the industrial sector. This review provides an understanding of program design, implementation approaches, market barriers addressed by the programs, and targeted sectors and technologies.

Finally, information developed in the program analysis was reviewed in light of the industrial market attributes developed in the characterization analysis. The fit between current programs and current opportunities and barriers was assessed to provide recommendations regarding future programs and areas (sectors and technologies) that should be targeted for additional efforts and additional studies.

2.2 DATA SOURCES

Collected data were used to develop an understanding of energy usage and energy efficiency in the industrial sector. Key data sources for each component of the study are discussed next, organized by component. A list of data sources is provided in Section 7.

2.2.1 Energy Usage Profiling Data

Utility Billing Data

Utility billing data provided the starting point for understanding energy use in the California industrial sector. Energy usage data for each industrial customer was extracted from utility billing systems using SIC code identifiers. Data was aggregated to 4-digit, 3-digit, or 2-digit SIC categories to identify key energy-using industries. In addition, each industry was examined in terms of total usage, average use per customer, concentration of usage among customers (whether the industry is dominated by a few large customers or many smaller-sized customers).

CEC Forecast Data

The California Energy Commission (CEC) prepares industrial energy forecasts by utility for 2-digit and selected 3-digit SIC codes. Data available at these levels include energy usage, value

of shipments, and number of employees. The CEC forecast data provided several useful elements that were used in the industrial usage profiling analysis, including forecasts of the fastest growing industries and the ability to examine energy intensities (i.e., kWh per dollar of shipments) over time.

MECS and Economic Census Data

Key data from the U.S. DOE Energy Information Administration (EIA) and the U.S. Census sources for this study include the Manufacturing Energy Consumption Survey (MECS). MECS data includes an end-use energy breakdown, including kWh and therms, by 2-digit SIC code and selected 3-digit and 4-digit SIC codes. Table 2-1 shows MECS end uses and energy consumption for the manufacturing industry (SICs 20-39) based on 1994 data, the most recent year available at the time of the analysis.

Table 2-1
1994 U.S. Manufacturing Energy Consumption by End Use from MECS

	Electric		Natural Gas	
	GWh	Percent	Bcf	Percent
TOTAL INPUTS	917,832	100%	5,962	100%
Indirect Uses-Boiler Fuel	12,467	1%	2,326	39%
Direct Uses-Total Process	729,423	79%	2,788	47%
Process Heating	86,383	9%	2,623	44%
Process Cooling and Refrigeration	46,650	5%	20	0.3%
Machine Drive	494,553	54%	93	2%
Electro-Chemical Processes	96,107	10%	-	-
Other Process Use	5,730	1%	52	1%
Direct Uses-Total Nonprocess	144,656	16%	705	12%
Facility Heating, Ventilation, and Air Conditioning	68,404	7%	341	6%
Facility Lighting	58,690	6%	-	-
Facility Support	14,806	2%	29	0.5%
Onsite Transportation	1,250	0.1%	1	0.02%
Conventional Electricity Generation	-	-	325	5%
Other Nonprocess Use	1,507	0.2%	9	0.2%
End Use Not Reported	31,286	3%	143	2%

As the table shows, key electric end uses are machine drives, electro-chemical processes, and process heating (and HVAC and lighting to a smaller extent). Key gas end uses are process heating and boilers. While the MECS data are reported only at the national level, they are the best sources of end-use consumption splits available.

Additional Studies

Information from additional studies was used to supplement the data developed from the above sources. Key data sources included: LBNL, U.S. DOE (EIA and OIT), U.S. Census, GRI, EPRI, ACEEE, and various trade associations.

There are several recent DOE studies that focus on the motor systems and steam systems markets. The United States Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999) includes on-site motor inventories for 265 sites. In this study motor system energy for key industries is disaggregated into key applications: pumps, fans, compressed air, refrigeration, materials handling, materials processing, and other uses. Estimates of energy efficiency potential by application and industry category are provided.

Studies by entities such as LBNL and EPRI focus on key industries and technologies. LBNL has recently completed industry-specific reports for the iron and steel, cement, pulp and paper, and chemicals industries (Martin, June 1999, July 1999, September 1999, and July 2000). Another LBNL study assesses energy-efficiency potential for steam systems (Worrell, 2001). Information from these sources and other trade association reports provide understanding of energy use and energy-efficiency potential for key industries and end uses.

2.2.2 Energy Efficiency Profiling Data

Utility Program Tracking Data

Utility program tracking data were collected and analyzed to develop an understanding of the impacts past utility programs have had on the industrial market. Key questions that were answered by the analysis of tracking data include:

- Who has participated in the programs (in terms of such factors as industry, customer size—when linked to usage data, geographic location, and repeat participation)?
- What measures have been implemented (most frequently, most savings, by which industries)?

Utility Evaluation Datasets

In addition to information on measure performance, evaluations and evaluation data of traditional utility programs provided some key insights into understanding net energy savings. Customer-specific net-to-gross ratios (NTGRs) were extracted from evaluation datasets and examined in terms of measures and industries. Information developed in this analysis sheds some light on which measures would be installed anyway without market intervention and which customer groups are already likely to install measures without program assistance.

Market Assessments, Support Studies, and Associated Data Sets

The more recent market effects and related baseline studies provided information on many key program-related issues, such as:

- Barriers to installing energy-efficiency measures/technologies (such as performance uncertainty, contractor uncertainty, financing, and time constraints);
- Customer knowledge of energy-efficiency measures and practices;
- Types of customers participating in programs and installing measures; and

- Motivation of customers behind equipment purchase decisions and the decision-making process in general.

Beyond the industrial impact evaluation studies, the utilities have commissioned a number of useful studies to support recent program planning and development activities. Examples include: the 1999 Large SPC Evaluation, 1999 Small/Medium Nonresidential MA&E Study, 1998 NSPC Study, PG&E Industry Characterization Studies for PG&E; compressed air baseline research for PG&E; Compressed Air Energy Savings Potential for PG&E, Industrial Saturation Survey for SCE, and Large Customer Wants and Needs reports for SCE. These studies provided additional coverage of the same data elements discussed regarding program evaluation data and were integrated into the energy-efficiency profiles to provide a more complete picture of current industrial energy-efficiency practices in California.

Market characterization activities associated with recent market effects studies were integrated into the analysis to provide an overview of the marketplace for energy-efficiency products and services. In some cases, estimates of energy-efficiency potential were available, although national studies (see below) are currently a better source of potential estimates.

Additional/National Studies

As with the energy usage profile sources, additional data sources were utilized to provide additional detail on energy efficiency in the industrial sector. Many of the same sources listed above were used again. While these additional data were generally focused at the national level or on regions outside of California, they could nonetheless be applied to the California market.

Descriptions of energy-efficiency technologies applicable to different industries were reviewed from sources such as DOE, LBNL, EPRI, GRI, and various trade associations. The DOE Office of Industrial Technology supports a number of programs that provided useful information for this study, including end-use-focused programs (Advanced Industrial Materials, Compressed Air, Steam, Motors, and Combustion) and industry-focused programs (Chemicals, Petroleum Refining, Glass, Forest Products, etc.).

Some of the recent LBNL reports include cost and savings potential estimates for selected energy-efficiency measures in studied industries. For example, Table 2-2, extracted from a recent LBNL report on the pulp and paper industry, shows costs and potential impacts for a number of industry-specific measures. While this level of detail may be useful for program planners, it was found to be difficult to adapt their nationwide findings to the California market within the scope of this project.

Other studies, such as the U.S. Industrial Motor study (DOE) discussed above and the Variable-Frequency Drives Study (Easton Consultants for the Northwest Energy Efficiency Alliance) also provided estimates of measure penetration and market potential.

Table 2-2
Cost of Conserved Energy for Selected Measures in U.S. Pulp and Paper Industry

	Primary CCE	Primary Energy savings	Cumulative primary energy savings	$3/GJ Internal rate of return	Simple payback time	Carbon Emissions Reduced
	$/GJ	GJ/t	GJ/t	%	years	kgC/t
Bar-type chip screens	-0.39	0.06	0.06	142%	0.7	0.38
Screen out thick chips	-0.39	0.06	0.12	--	0.7	0.38
Boiler maintenance	0.04	0.36	0.48	>500%	0.0	2.26
Improved Process Control	0.04	0.38	0.86	292%	0.2	2.41
Condensate Return	0.14	0.08	0.93	299%	0.3	0.48
Automatic Steam Trap Monitoring	0.19	0.63	1.57	152%	0.3	4.02
Flue Gas Heat Recovery	0.29	0.18	1.75	324%	0.7	1.13
Continuous digester modifications	0.39	0.42	2.16	>500%	0.3	2.63
Leak Repair	0.44	0.09	2.25	205%	0.1	0.58
Infrared profiling	0.45	0.13	2.38	201%	0.5	0.57
Batch digester modifications	0.55	0.41	2.79	111%	0.5	2.59
Blowdown Steam Recovery	0.82	0.14	2.92	95%	0.9	0.86
Pinch Analysis	0.95	0.51	3.43	>500%	1.0	3.22
Steam trap maintenance	1.10	1.27	4.70	63%	0.2	8.04
Efficient motors	1.55	1.25	5.95	83%	1.6	19.57
Lime kiln modifications	1.63	0.06	6.01	28%	1.8	1.01
Reduced air requirements	2.61	0.45	6.46	85%	2.9	3.01
Refiner Improvements	3.05	0.01	6.47	17%	3.4	0.20
Heat recovery in thermomechanical pulping	3.27	0.05	6.53	23%	4.7	0.27
Energy-efficient lighting	3.43	0.02	6.55	15%	3.7	0.33
Condebelt drying	3.50	1.21	7.76	82%	3.8	8.37
Optimization of regular equipment	4.60	0.07	7.82	--	0.0	1.02
Biopulping	5.16	0.04	7.87	-7%	30.1	0.78
Extended nip press (shoe press)	5.96	0.91	8.78	47%	8.1	5.76
RTS	6.73	0.02	8.80	-4%	7.4	0.38
Continuous digesters	7.02	1.26	10.06	49%	7.7	7.21
Washing presses	8.47	0.03	10.09	3%	7.8	0.19
Hot Pressing	8.88	0.09	10.18	-2%	9.7	0.55
High consistency forming	8.97	0.42	10.60	10%	10.5	3.11
Waste heat recovery	9.77	0.21	10.81	12%	34.4	1.35

Source: LBNL, July 2000, *Opportunities to Improve Energy Efficiency and Reduce Greenhouse Gas Emmissions in the US Pulp and Paper Industry*.

2.2.3 Current Program Information

Information on current programs was gathered from each utilities advice filing, PY2001 1st Quarterly Reports, and program manager interviews.

2.3 ANALYSIS APPROACH

2.3.1 Energy Usage Profiles

Electronic utility billing data, CEC forecast data, and MECS data were combined to develop a comprehensive description of energy usage in the California industrial sector. The energy usage profiling analysis identified where energy is being consumed and where growth in energy usage is coming from. This analysis forms one-half of the energy-efficiency characterization analysis.

Within Industry Analysis

For each industry group, identified by SIC, key energy usage parameters were developed. Some of the key parameters that were developed include (key parameters show in parentheses):

- Current energy use (kWh, kW, therms);

- Number of customers or accounts;
- Usage trends (projected growth rates for the next 5 years);
- Energy intensity (per customer and per value of shipments);
- Concentration of usage (percent of use by the top 10% of customers); and
- Energy usage and customer counts broken out by customer size (number of sites, kWh, kW, and therms).

These usage parameters were used to provide cross-industry comparisons and to help identify key industries that will be targeted for more intensive study.

Additional information that was developed for the energy usage profiles included:

- Sub-industry usage detail (at the 3-digit or 4-digit SIC level)
- A breakout of usage by end use (using national detail from MECS)
- A customer size breakdown.

To supplement the statistical descriptors of energy use, information from industry and technology reports was reviewed and included in the analysis where appropriate. Such information includes factors such as the key industrial processes used in a particular industry and new developments in energy-using technologies.

Between Industry Analysis

Using data developed for each industrial group, a comparison of energy use between SIC groups was performed. This analysis focused on:

- Identifying and displaying each group's contribution to total industrial energy use;
- Identifying the most important energy consuming end uses across industries;
- Comparing and contrasting key energy usage parameters across industries; and
- Identifying the most important industries to study, in terms of energy use.

For identification of the key industries for additional study, key usage parameters were reviewed, focusing on:

- Largest energy-consuming industries;
- The most energy-intensive industries (per dollar of revenue);
- The fastest growing industries; and
- Presence of the key end uses that consume the most energy in the industrial sector.

2.3.2 Energy Efficiency Profiles

Energy-efficiency profiles were developed using electronic program tracking and evaluation data and descriptive information from additional studies developed for the California and U.S. markets.

Utility program tracking data were used to provide:

- Indications of what types of measures have been installed over the past few years and the penetration of those measures over time;
- The industries that have been using the programs the most (and the least); and
- The level of repeat participation by individual customers.

Program evaluation data provided information on:

- NTGRs by industry group – to assess whether the programs have been useful in promoting additional energy efficiency;
- Customer decision-making issues; and
- Customer knowledge of energy-efficiency measures and barriers to installing energy-efficiency measures (mostly from the more recent market effects evaluations).

Additional study data were used to fill in the energy-efficiency picture:

- Energy savings potential was extracted from studies on individual industries and technologies; and
- Saturations of measures were assessed and compared to penetration information developed from program tracking data.

Analysis of the above sources provided a good, initial understanding of the industrial energy-efficiency market, including.

- Identification of key energy-efficiency end uses and measures, within and across industries;
- Estimates of current measure penetration and future energy-savings potential;
- Barriers to the effective implementation of energy-efficiency measures and practices; and
- Customer/industry characteristics, motivation, and decision-making issues that must be taken into account in the delivery of energy-efficiency products and services.

2.3.3 Industrial Energy Efficiency Market Characterization

The industrial energy usage profile and the energy-efficiency profile were integrated to characterize the market for industrial energy efficiency. Key elements of the characterization include:

- Identification of the most important industries for targeting of energy-efficiency products and services, based on factors such as size, growth, energy-efficiency opportunities, untapped potential, and likelihood of investing in energy-efficiency projects (for example, mature, cost-focused industries may be more likely to invest in technologies that reduce electric costs than newer, fast-growing industries);
- Identification of the most important energy-efficiency technologies that cut across industries or are applicable to the most important industries; and

- Identification of key barriers that must be addressed (by industry group and measure) to promote a viable market for energy-efficiency products.

Next, the current California energy-efficiency program portfolio was reviewed in light of the findings from the characterization analysis. A gap analysis was conducted, focusing on the following key questions:

- Are the current programs addressing the most important industry groups and measures in terms of energy savings potential?
- Are the current programs targeting the most significant barriers to viable energy-efficiency markets for the targeted measures and industry groups?

Based on the characterization analysis, policy and program recommendations are made to improve industrial energy-efficiency uptake, identify key industry groups for future research, and propose key industrial energy-efficiency products/services that could be tracked with regard to market penetration.

3 ENERGY USAGE RESULTS

This section presents industrial energy usage characterization results. First, industrial energy usage is profiled. Next industrial energy-efficiency measures are discussed, and energy-efficiency potential estimates are presented. Finally, utility energy-efficiency program accomplishments for the 1995-1999 period are summarized and compared against the energy-efficiency potential estimates.

3.1 ENERGY CONSUMPTION AND CUSTOMERS BY INDUSTRY

The industrial sector in California accounts for over 20% of the state's electricity consumption and over 40% of the state's natural gas consumption, based on 1998 data developed by the CEC (Table 3-1).

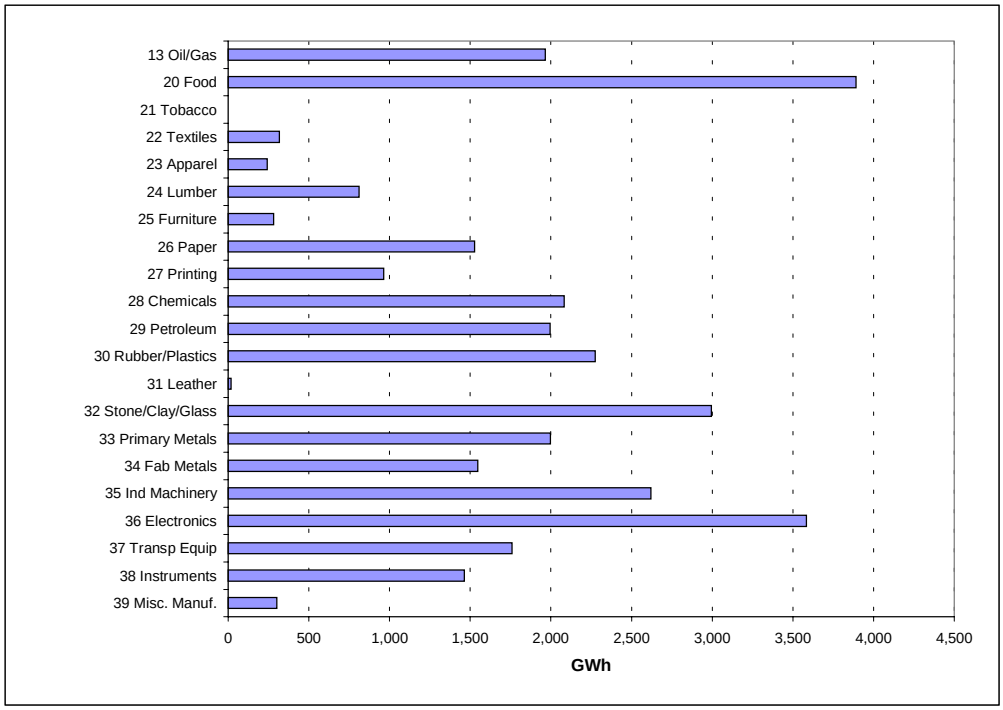
Table 3-1
Electricity and Natural Gas Consumption in California

	Electricity		Natural Gas	
Sector	**GWh**	**% of Total**	**Mth**	**% of Total**
Residential	75,388	31%	5,521	38%
Commercial	87,093	36%	2,103	15%
Industrial	**51,996**	**21%**	**6,341**	**44%**
Agricultural	14,661	6%		0%
Other	15,270	6%	379	3%
Total	244,408	100%	14,344	100%

Source: CEC data for 1998 (CEC, June 2000)

Electric energy consumption (as tabulated from PG&E, SDG&E, and SCE billing data) is shown for key industrial SIC groups in Figure 3-1. The largest four industries (SIC 20-Food, SIC 36-Electronics, SIC 32-Stone, Clay and Glass, and 35-Industrial Machinery) consume over 2,500 GWh each. Together, these industries account for about 40% of industrial electric usage. The next five largest industries (SIC-30 Rubber and Plastics, SIC-28 Chemicals, SIC 33-Primary Metals, SIC 29-Petroleum Refining, and SIC 13-Oil and Gas Extraction) each consume about 2,000 GWh per year, accounting for another 30% of industrial consumption.

Figure 3-1
Electricity Consumption by 2-Digit SIC Grouping



Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Table 3-2 shows industrial electricity consumption by utility. SCE accounts for about 53% of industrial electricity consumption, followed by PG&E at just under 43% and SDG&E at just under 5%.

Table 3-2
Electricity Consumption by Utility

	PG&E		SCE		SDG&E	
Industry	GWh	% Calif.	GWh	% Calif.	GWh	% Calif.
13 Oil/Gas	842	43%	1,123	57%	0.04	0%
20 Food	2,464	63%	1,370	35%	57	1%
21 Tobacco	0	0%	0	54%	0.02	46%
22 Textiles	47	15%	269	84%	2	1%
23 Apparel	32	13%	199	82%	12	5%
24 Lumber	686	84%	118	15%	9	1%
25 Furniture	34	12%	240	85%	9	3%
26 Paper	601	39%	918	60%	9	1%
27 Printing	372	39%	503	52%	89	9%
28 Chemicals	645	31%	1,297	62%	140	7%
29 Petroleum	993	50%	997	50%	4	0%
30 Rubber/Plastics	601	26%	1,616	71%	60	3%
31 Leather	9	50%	9	48%	0.5	3%
32 Stone/Clay/Glass	1,303	43%	1,663	56%	29	1%
33 Primary Metals	624	31%	1,353	68%	19	1%
34 Fab Metals	430	28%	1,049	68%	69	4%
35 Ind Machinery	1,693	65%	731	28%	196	7%
36 Electronics	1,590	44%	1,609	45%	384	11%
37 Transp Equip	337	19%	1,231	70%	191	11%
38 Instruments	595	41%	678	46%	192	13%
39 Misc. Manuf.	43	14%	196	65%	64	21%
Total	13,941	45%	17,169	55%	1,536	5%

Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Table 3-3 presents the largest energy-consuming industries at the 4-digit SIC code level. These 20 industries account for about 40% of industrial electricity consumption, with much of the usage concentrated in the top 6 or 7 industries. Eight of the top 20 electricity-consuming industries are also included in the top 20 natural gas consuming industries. The top two electricity industries, Oil and Gas Extraction (SIC 1311) and Petroleum Refining (SIC 2911) are also the top two natural gas industries.

Table 3-3
Top 20 Electricity Consuming Industries at the 4-Digit SIC Code Level

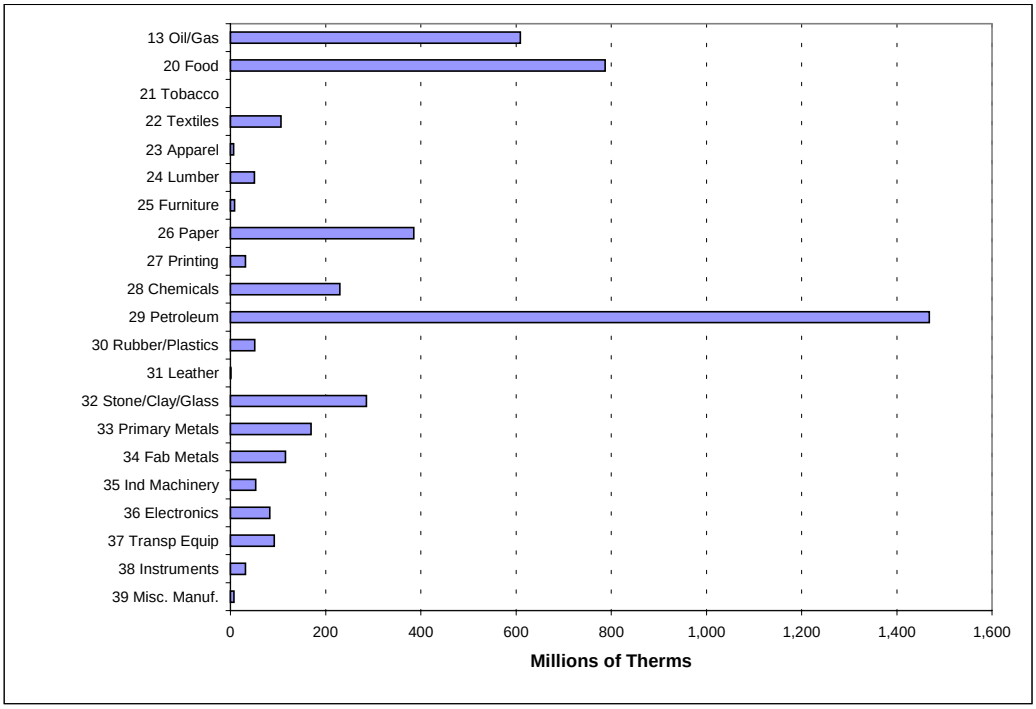
Rank	4-Digit SIC Group	Gas Rank	GWh	% of Tot Ind GWh	MW	% of Tot Ind MW
1	1311 Crude Petroleum And Natural Gas	2	1,944	5.7%	411	5.4%
2	2911 Petroleum Refining	1	1,833	5.4%	307	4.0%
3	3241 Cement, Hydraulic		1,526	4.5%	224	2.9%
4	3674 Semiconductors And Related Devices	19	1,281	3.8%	218	2.9%
5	3089 Plastics Products, Nec		1,153	3.4%	226	3.0%
6	3312 Blast Furnaces And Steel Mills	8	1,081	3.2%	203	2.7%
7	2813 Industrial Gases		832	2.5%	102	1.3%
8	3728 Aircraft Parts And Equipment, Nec		555	1.6%	102	1.3%
9	3672 Printed Circuit Boards		457	1.3%	103	1.3%
10	2834 Pharmaceutical Preparations		456	1.3%	89	1.2%
11	3572 Computer Storage Devices		452	1.3%	67	0.9%
12	2752 Commercial Printing, Lithographic		434	1.3%	112	1.5%
13	2033 Canned Fruits And Vegetables	3	390	1.2%	150	2.0%
14	2421 Sawmills And Planing Mills, General	20	388	1.1%	110	1.4%
15	3221 Glass Containers	7	384	1.1%	59	0.8%
16	2084 Wines, Brandy, And Brandy Spirits		376	1.1%	144	1.9%
17	3679 Electronic Components, Nec		363	1.1%	90	1.2%
18	3663 Radio And Tv Communications Equipment		357	1.1%	74	1.0%
19	2026 Fluid Milk	14	346	1.0%	58	0.8%
20	3570 Computer And Office Equipment		344	1.0%	76	1.0%

Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Natural gas consumption figures are shown in Figure 3-2. Petroleum refining (SIC 29) is by far the largest consumer of natural gas. The next five largest consuming industries (SIC 20-Food, SIC 13-Oil and Gas, SIC 26-Paper, SIC 32-Stone, Clay, and Glass, and SIC 28-Chemicals) all use over 200 Mth (million therms) per year each. These six industries account for over 80% of industrial gas consumption.

Table 3-4 shows industrial natural gas consumption by utility. SCG accounts for about 55% of industrial gas consumption, followed by PG&E at 42% and SDG&E at 3%. SCG accounts for almost all of the natural gas consumed in the oil and gas extraction industry (SIC 13), which is used for steam injection to extract heavy oils in the southern portion of the Central Valley and to drive gas-fired well pumps and compressors.

Figure 3-2
Natural Gas Consumption by 2-Digit SIC Grouping



Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Table 3-4
Natural Gas Consumption by Utility

	PG&E		SCG		SDG&E	
Industry	MTh	% Calif.	Mth	% Calif.	Mth	% Calif.
13 Oil/Gas	3.9	1%	605.1	99%	0.0	0%
20 Food	497.7	63%	282.2	36%	7.4	1%
21 Tobacco	0.0	82%	0.0	18%	0.0	0%
22 Textiles	1.7	2%	104.6	98%	0.0	0%
23 Apparel	0.9	13%	5.6	84%	0.2	3%
24 Lumber	47.7	95%	2.4	5%	0.0	0%
25 Furniture	0.3	4%	8.2	96%	0.1	1%
26 Paper	103.7	27%	281.2	73%	0.1	0%
27 Printing	11.0	35%	19.7	63%	0.9	3%
28 Chemicals	100.3	44%	90.8	40%	38.6	17%
29 Petroleum	795.3	54%	667.5	45%	5.6	0%
30 Rubber/Plastics	20.0	39%	29.5	58%	1.7	3%
31 Leather	0.6	88%	0.1	12%	0.0	0%
32 Stone/Clay/Glass	190.0	67%	92.8	33%	2.4	1%
33 Primary Metals	31.6	19%	136.5	81%	0.8	0%
34 Fab Metals	27.9	24%	84.9	74%	2.2	2%
35 Ind Machinery	26.0	50%	12.8	24%	13.7	26%
36 Electronics	39.0	47%	22.6	27%	20.9	25%
37 Transp Equip	24.6	27%	48.9	53%	18.2	20%
38 Instruments	12.3	39%	8.5	27%	10.6	34%
39 Misc. Manuf.	1.3	20%	4.7	69%	0.7	11%
Total	1,936.0	42%	2,508.6	55%	123.9	3%

Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Table 3-5 presents the largest natural gas-consuming industries at the 4-digit SIC code level. These 20 industries account for over 70% of industrial gas consumption, with over 50% of total industrial usage concentrated in the top four industries, and 40% of usage concentrated in the top two industries.

Table 3-5
Top 20 Natural Gas Consuming Industries at the 4-Digit SIC Code Level

Rank	4-Digit SIC Group	Elec Rank	Mil Therms	% of Tot Ind Thm
1	2911 Petroleum Refining	2	1,399	30.5%
2	1311 Crude Petroleum And Natural Gas	1	603	13.1%
3	2033 Canned Fruits And Vegetables	13	258	5.6%
4	2621 Paper Mills		186	4.0%
5	2631 Paperboard Mills		130	2.8%
6	2819 Industrial Inorganic Chemicals, Nec		89	1.9%
7	3221 Glass Containers	15	83	1.8%
8	3312 Blast Furnaces And Steel Mills	6	72	1.6%
9	2034 Dehydrated Fruits, Vegetables, Soups		66	1.4%
10	2261 Finishing Plants, Cotton		62	1.3%
11	2951 Asphalt Paving Mixtures And Blocks		60	1.3%
12	2063 Beet Sugar		53	1.1%
13	3275 Gypsum Products		52	1.1%
14	2026 Fluid Milk	19	41	0.9%
15	2037 Frozen Fruits And Vegetables		41	0.9%
16	2833 Medicinals And Botanicals		39	0.9%
17	2099 Food Preparations, Nec		38	0.8%
18	3341 Secondary Nonferrous Metals		36	0.8%
19	3674 Semiconductors And Related Devices	4	33	0.7%
20	2421 Sawmills And Planing Mills, General	14	32	0.7%

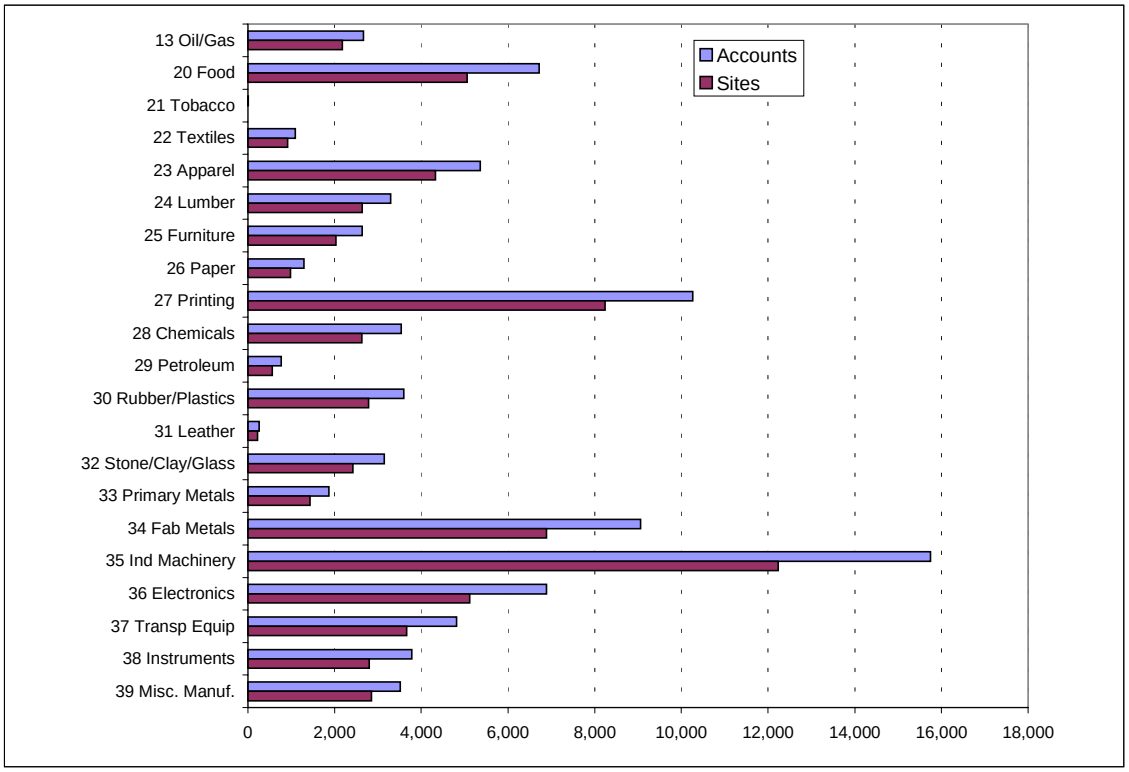
Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Figure 3-3 shows counts of sites and customer accounts. The Metal Durables industries (SICs 34-38), along with Food Processing (SIC 20), Printing and Publishing (SIC 27), and Apparel (SIC 23) show the largest number of accounts and sites. Site counts, which were developed using each utility's Site/Premise code indicators, fall below the number of accounts because larger facilities are often served through several accounts. Note that sites served by both SCE and SCG will be counted twice, as there is no way to readily aggregate accounts across the two utilities.

3.2 ENERGY USAGE TRENDS

Using CEC forecast data, *projected* growth rates were calculated for the 2000-to-2005 period. Projected electric growth rates are shown in Figure 3-4 and projected natural gas growth rates are shown in Figure 3-5.

Figure 3-3
Industrial Accounts and Sites

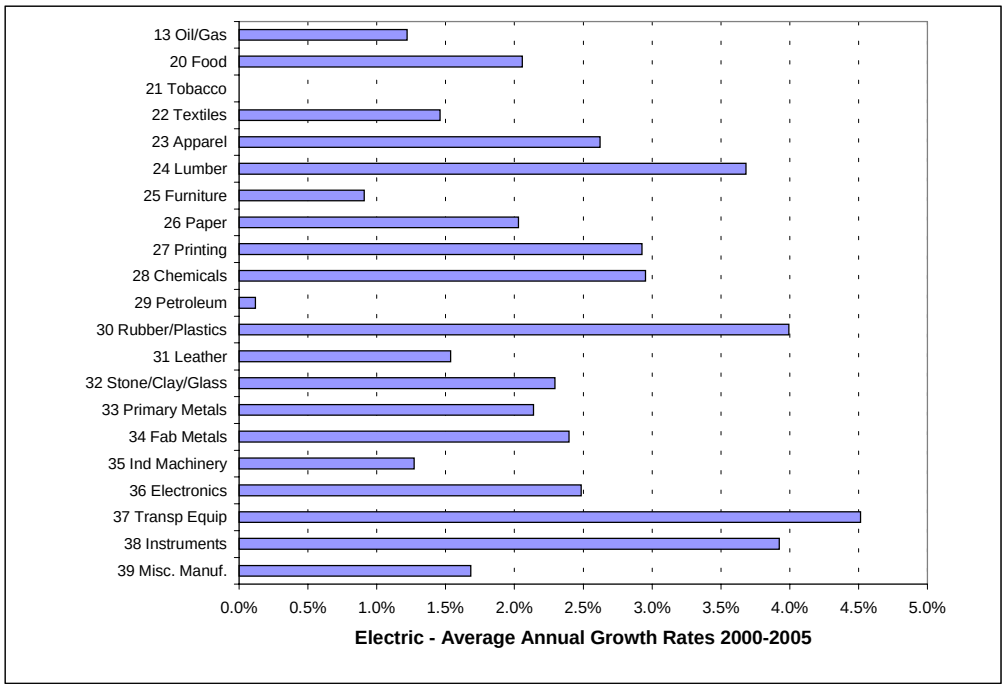


Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

The industries (of larger size) with the fastest growing electric usage include Lumber (SIC 24), Chemicals (SIC 28), Rubber and Plastics (SIC 30), Electronics (SIC 36), Transportation Equipment (SIC 37), and Instruments (SIC 38). These industries show electric growth rates ranging from 2.5% to 4.5%.

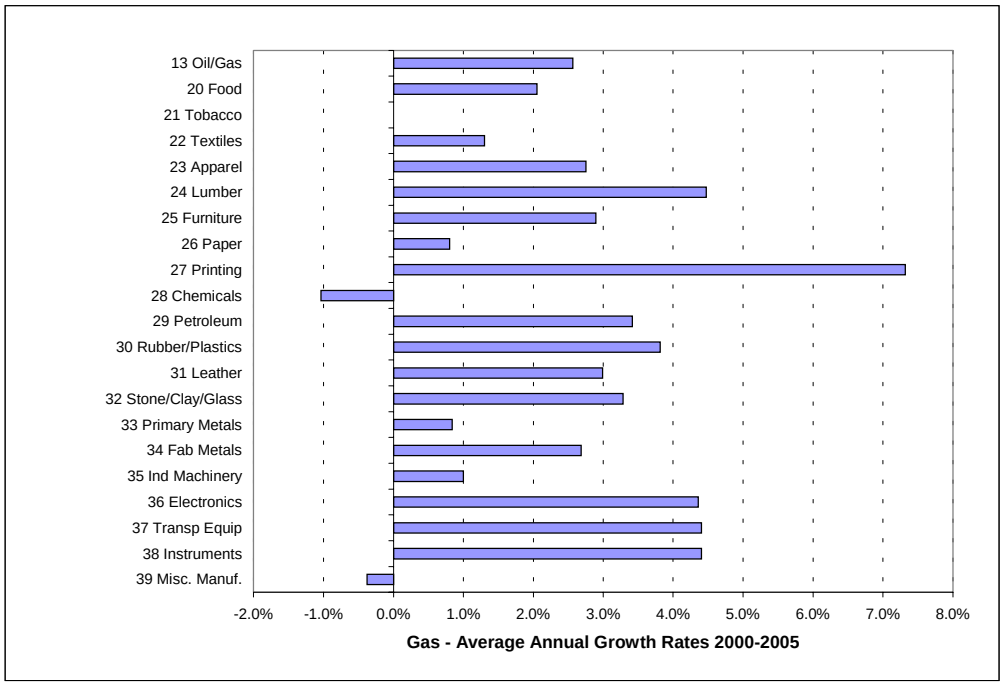
The industries with the fastest growing gas usage tend to be smaller gas-consuming industries: Lumber (SIC 24), Printing and Publishing (SIC 27), Rubber and Plastics (SIC 30), Electronics (SIC 36), Transportation Equipment (SIC 37), and Instruments (SIC 38). The largest natural gas consuming industries (SIC 13-Oil and Gas Extraction, SIC 20-Food Processing, SIC 29-Petroleum, and SIC 32-Stone, Clay, and Glass) show gas growth rates in the 2% to 3.5% range.

Figure 3-4
Projected Electric Growth Rates 2000-2005



Source: CEC Forecast Data

Figure 3-5
Projected Natural Gas Growth Rates 2000-2005

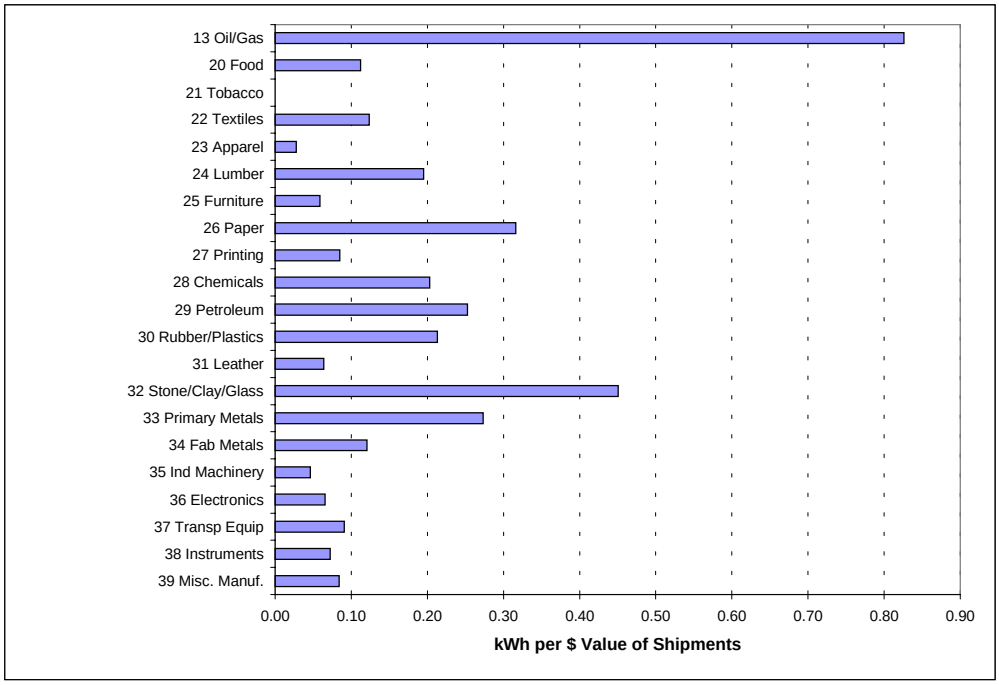


Source: CEC Forecast Data

3.3 ENERGY INTENSITY

Energy intensity was calculated by industry, using CEC forecast data for California on energy usage and value of shipments. Electric energy intensity is presented in Figure 3-6 and natural gas energy intensity is presented in Figure 3-7. Eight industries show electric energy intensities of 0.20 kWh or greater per dollar of shipments. These include Oil and Gas Extraction (SIC 13), Paper (SIC 26), and Stone, Clay, and Glass (SIC 32) at over 0.30 kWh per dollar, and Lumber (SIC 24), Chemicals (SIC 28), Petroleum (SIC 29), Rubber and Plastics (SIC 30), and Primary Metals (SIC 33) at between 0.20 and 0.30 kWh per dollar of shipments.

Figure 3-6
Electric Energy Intensity – kWh per Dollar of Shipments

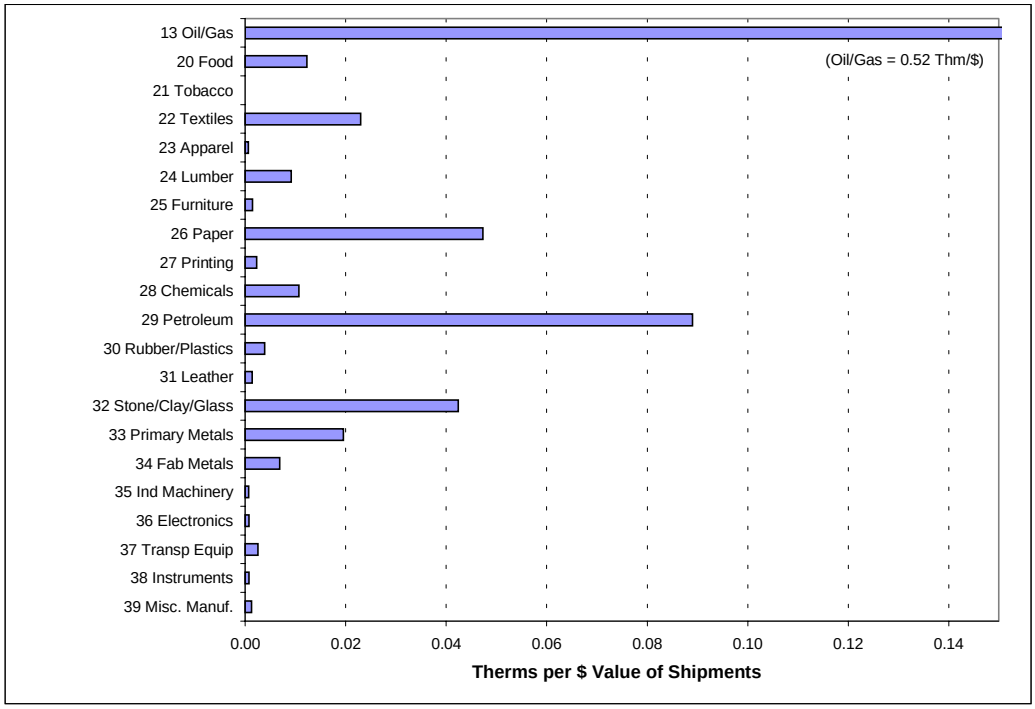


Source: CEC Forecast Data

The Oil and Gas Extraction industry (SIC 13) is by far the most intensive natural-gas-consuming industry (as well as the most intensive electricity consuming industry). Other intensive natural-gas-consuming industries include Textiles (SIC 22), Paper (SIC 26), Petroleum (SIC 29), Stone, Clay, and Glass (SIC 32), and Primary Metals (SIC 33). All these industries use 0.02 therms or more per dollar of shipments.

By applying typical energy prices that have been faced by industrial customers over the past several years (approximately $0.065 per kWh and $0.50 per therm), the fraction of revenues that are paid out to energy costs can be estimated. Results are presented in Figure 3-8.

Figure 3-7
Natural Gas Energy Intensity – Therms per Dollar of Shipments



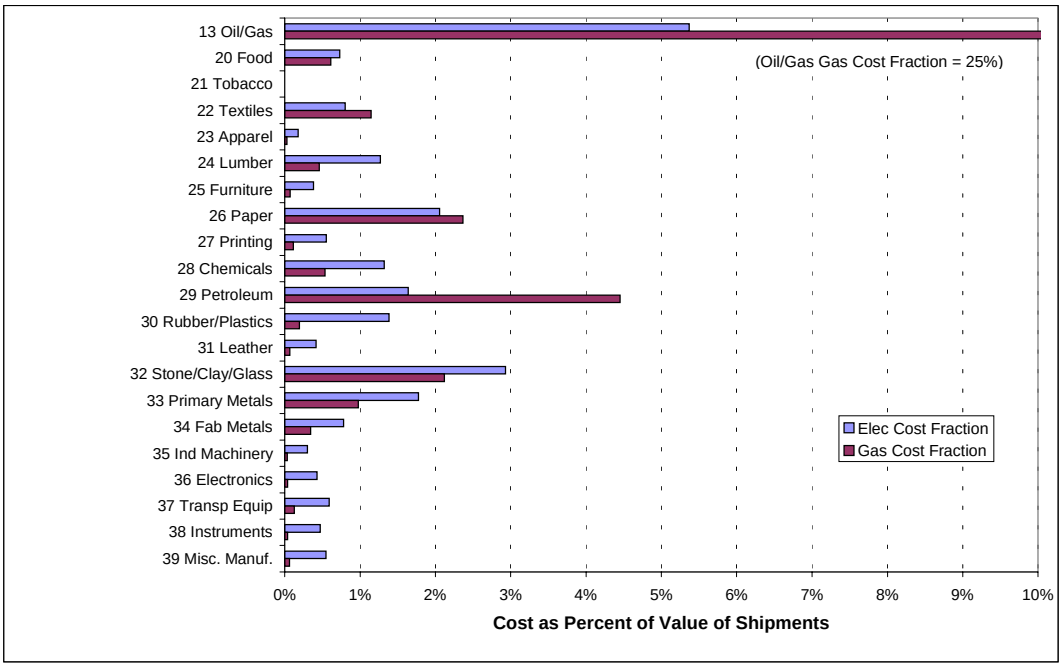
Source: CEC Forecast Data

As expected, the Oil and Gas Extraction industry (SIC 13) has the largest percent energy costs, though these estimates are probably inflated as the large oil-producing companies can usually obtain energy at below-average rates. Other industries that pay the highest fraction of revenues to energy costs include Paper (SIC 26), Petroleum (SIC 29), Stone, Clay, and Glass (SIC 32), and Primary Metals (SIC 33). These are traditional "heavy" industries. The "high-tech" industries (SICs 35-38) generally pay out a much smaller fraction of revenues to energy costs.

In general, electric and gas bills do not contribute a large portion of each industry's costs. In most cases the combined gas and electric bills amount to less than 2% of the value of shipments. In many cases the combined bills amount to less than 1% of the value of shipments.

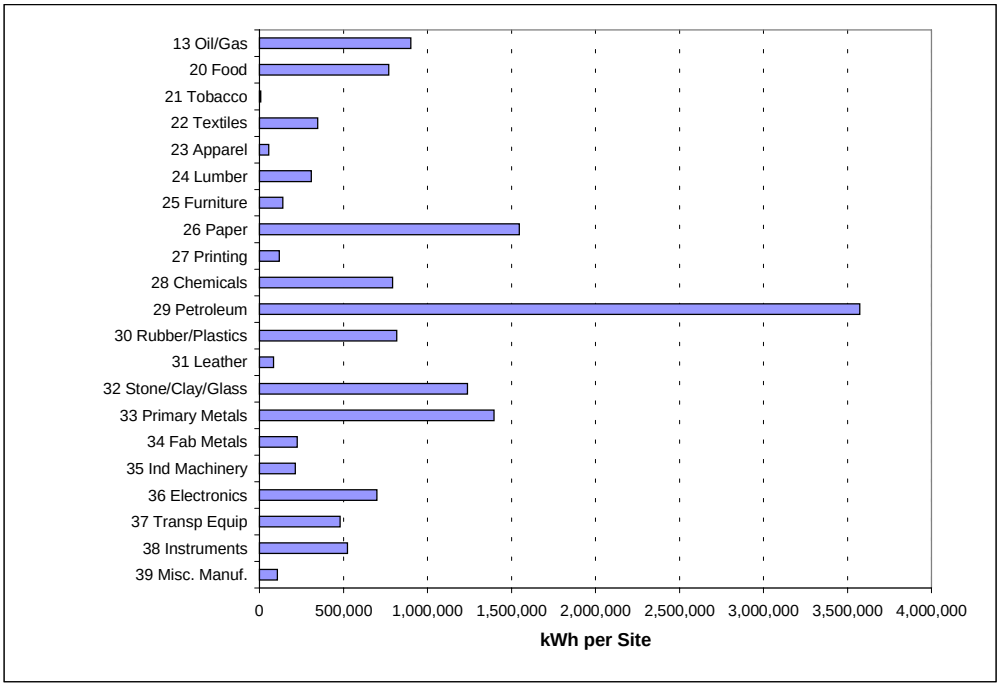
Average electricity use per site is presented in Figure 3-9, and average natural gas use per site is presented in Figure 3-10. The heavier industries (SICs 13, 20, 26, 29, 32, and 33) tend to have the highest average use per site. These industries tend to be associated with large, energy-intensive production facilities.

Figure 3-8
Energy Cost as Percent of Value of Shipments



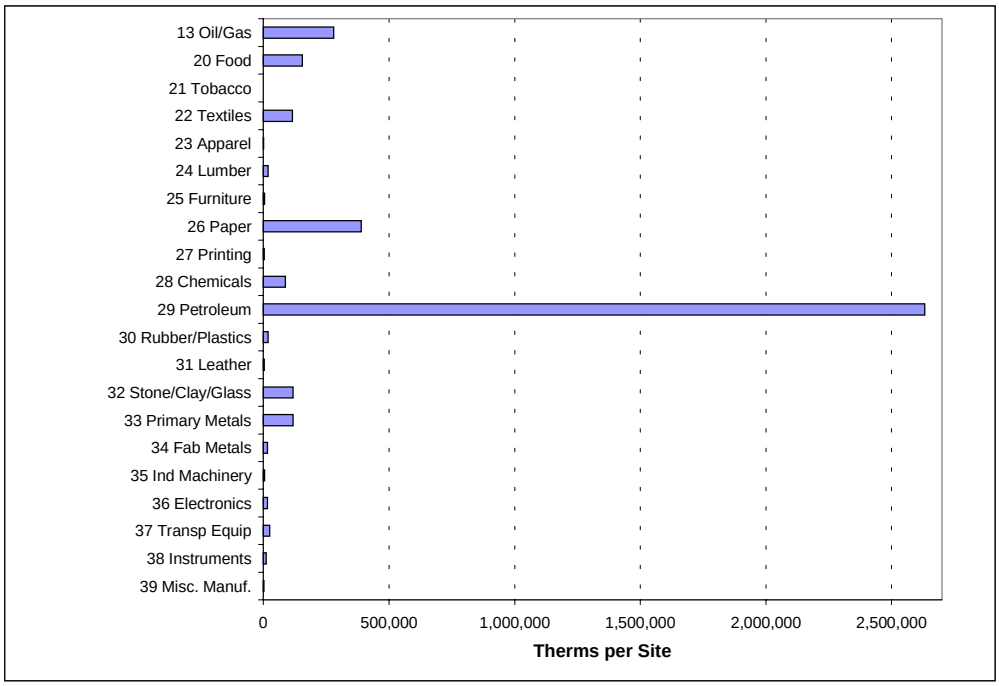
Source: CEC Forecast Data
Assumes energy costs of $0.065/kWh and $0.50/therm.

Figure 3-9
Average Electricity Usage Per Site



Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

Table 3-6
Average Natural Gas Usage Per Site



Source: Utility Billing Data (PG&E, SCG, SCE, SDG&E)

3.4 ENERGY USE CONCENTRATIONS

A look at the concentration of energy use for each industry examines whether an industry is characterized by a larger number of more-equal-sized firms or whether energy use within an industry is dominated by a relatively few larger firms. Table 3-7 shows, by industry, the concentration in electric usage for the top 10% of electricity-consuming sites. Table 3-8 shows the same figures for natural gas consumption. As Table 3-7 indicates, the top 10% of sites in most industries consume 70% or more of the kWh in their industry. Overall, about 4,500 industrial sites account for about 75% of the industrial kWh consumption and 83% of the kW consumption. As Table 3-8 shows, the concentration of gas usage is even higher among the larger sites, with the top 10% of gas-consuming sites using 93% of the natural gas.

Table 3-7
Concentration of Electric Usage in Top 10% of Sites

Industry Category	Largest 10% of Sites				
	# Sites Top 10%	GWh Top 10%	% of Total GWh	MW Top 10%	% of Total MW
13 Oil/Gas	173	1,839	94%	363	87%
20 Food	315	3,028	78%	690	70%
21 Tobacco	1	0	46%	0	.
22 Textiles	31	213	67%	35	58%
23 Apparel	282	164	68%	45	71%
24 Lumber	207	735	90%	189	83%
25 Furniture	127	203	72%	52	64%
26 Paper	62	1,087	71%	172	52%
27 Printing	572	802	83%	209	81%
28 Chemicals	154	1,797	86%	311	76%
29 Petroleum	33	1,873	94%	311	85%
30 Rubber/Plastics	179	1,690	74%	265	61%
31 Leather	12	13	69%	4	67%
32 Stone/Clay/Glass	157	2,833	95%	470	86%
33 Primary Metals	72	1,677	84%	339	76%
34 Fab Metals	433	1,205	78%	294	69%
35 Ind Machinery	769	2,237	85%	496	79%
36 Electronics	320	2,820	79%	504	69%
37 Transp Equip	255	1,536	87%	357	82%
38 Instruments	182	1,132	77%	230	68%
39 Misc. Manuf.	186	248	82%	71	81%

Source: Utility Billing Data

Table 3-8
Concentration of Natural Gas Usage in Top 10% of Sites

Industry Category	Largest 10% of Sites		
	# Sites Top 10%	Therms Top 10%	% of Total Therms
13 Oil/Gas	32	596	98%
20 Food	253	678	86%
22 Textiles	63	89	84%
23 Apparel	170	5	71%
24 Lumber	88	50	99%
25 Furniture	85	8	92%
26 Paper	46	359	93%
27 Printing	395	30	94%
28 Chemicals	133	220	96%
29 Petroleum	27	1,394	95%
30 Rubber/Plastics	126	48	93%
31 Leather	12	1	92%
32 Stone/Clay/Glass	108	275	96%
33 Primary Metals	83	149	88%
34 Fab Metals	323	103	89%
35 Ind Machinery	606	47	90%
36 Electronics	264	76	92%
37 Transp Equip	125	89	97%
38 Instruments	137	29	92%
39 Misc. Manuf.	121	6	85%

Source: Utility Billing Data

3.5 CUSTOMER SIZE BREAKDOWN

Tables 3-9 and 3-10 break out industrial electricity and natural gas usage facility size. The top half of each table shows numbers of sites and levels of energy use; the bottom half shows percentages. As the tables indicate, larger facilities account for a very large fraction of industrial energy use. Overall for electricity, 4% of all sites are "large" sites, and these large sites account for about 74% of industrial electric consumption. For natural gas, the large facilities account for 4% of the total number of sites and about 94% of industrial natural gas consumption.

Table 3-9
Industrial Electricity Use by Facility Size

	Small (under 100 kW)			Medium (100-500 kW)			Large (over 500 kW)		
Industry	Sites	GWh	MW	Sites	GWh	MW	Sites	GWh	MW
13 Oil/Gas	1,489	157	19	141	151	30	102	1,657	368
20 Food	2,132	235	39	576	451	138	442	3,205	810
21 Tobacco	4	0.1	0	0	0	0	0	0	0
22 Textiles	208	34	4	67	70	15	38	215	42
23 Apparel	2,644	107	24	158	95	29	14	41	10
24 Lumber	1,765	67	17	218	113	46	82	633	166
25 Furniture	1,068	64	17	173	99	34	29	120	31
26 Paper	320	135	8	173	162	42	130	1,230	281
27 Printing	5,171	207	42	449	293	94	95	464	122
28 Chemicals	1,078	265	22	322	252	76	135	1,565	312
29 Petroleum	184	740	2	75	57	20	71	1,197	345
30 Rubber/Plastics	1,124	225	24	442	374	101	224	1,677	307
31 Leather	100	4	1	17	10	4	1	5	1
32 Stone/Clay/Glass	1,168	66	19	275	156	61	126	2,773	469
33 Primary Metals	397	57	9	188	150	47	132	1,790	389
34 Fab Metals	3,499	215	62	682	449	146	149	883	218
35 Ind Machinery	6,651	335	87	803	575	172	234	1,711	369
36 Electronics	2,160	274	43	723	651	169	318	2,659	523
37 Transp Equip	2,057	217	31	359	273	80	136	1,270	323
38 Instruments	1,298	98	23	369	309	84	156	1,058	233
39 Misc. Manuf.	1,677	63	14	155	98	34	32	142	39
Total	**36,194**	**3,565**	**507**	**6,365**	**4,788**	**1,421**	**2,646**	**24,294**	**5,356**
	Small (under 100 kW)			**Medium (100-500 kW)**			**Large (over 500 kW)**		
Industry	**% Sites**	**% GWh**	**% MW**	**% Sites**	**% GWh**	**% MW**	**% Sites**	**% GWh**	**% MW**
13 Oil/Gas	86%	8%	5%	8%	8%	7%	6%	84%	88%
20 Food	68%	6%	4%	18%	12%	14%	14%	82%	82%
21 Tobacco	100%	100%	-	0%	0%	-	0%	0%	-
22 Textiles	66%	11%	7%	21%	22%	25%	12%	67%	68%
23 Apparel	94%	44%	38%	6%	39%	46%	0%	17%	16%
24 Lumber	85%	8%	7%	11%	14%	20%	4%	78%	72%
25 Furniture	84%	23%	21%	14%	35%	41%	2%	42%	38%
26 Paper	51%	9%	2%	28%	11%	13%	21%	81%	85%
27 Printing	90%	22%	16%	8%	30%	36%	2%	48%	48%
28 Chemicals	70%	13%	5%	21%	12%	18%	9%	75%	76%
29 Petroleum	56%	37%	1%	23%	3%	6%	22%	60%	94%
30 Rubber/Plastics	63%	10%	6%	25%	16%	23%	13%	74%	71%
31 Leather	85%	21%	18%	14%	52%	61%	1%	27%	21%
32 Stone/Clay/Glass	74%	2%	3%	18%	5%	11%	8%	93%	85%
33 Primary Metals	55%	3%	2%	26%	8%	11%	18%	90%	87%
34 Fab Metals	81%	14%	14%	16%	29%	34%	3%	57%	51%
35 Ind Machinery	87%	13%	14%	10%	22%	27%	3%	65%	59%
36 Electronics	67%	8%	6%	23%	18%	23%	10%	74%	71%
37 Transp Equip	81%	12%	7%	14%	16%	18%	5%	72%	74%
38 Instruments	71%	7%	7%	20%	21%	25%	9%	72%	68%
39 Misc. Manuf.	90%	21%	16%	8%	32%	39%	2%	47%	45%
Total	**80%**	**11%**	**7%**	**14%**	**15%**	**20%**	**6%**	**74%**	**74%**

Source: Utility Billing Data

Table 3-10
Industrial Natural Gas Use by Facility Size

Industry	Small		Large	
	Sites	Mth	Sites	Mth
13 Oil/Gas	279	4	44	605
20 Food	2,119	55	406	732
21 Tobacco	2	0.003	0	0
22 Textiles	544	11	85	96
23 Apparel	1,697	6	1	0.3
24 Lumber	860	3	18	47
25 Furniture	846	6	4	3
26 Paper	374	6	90	379
27 Printing	3,924	10	25	22
28 Chemicals	1,247	18	86	212
29 Petroleum	152	4	116	1,464
30 Rubber/Plastics	1,214	12	46	39
31 Leather	119	0.1	1	1
32 Stone/Clay/Glass	1,001	15	83	270
33 Primary Metals	741	17	91	152
34 Fab Metals	3,156	39	78	76
35 Ind Machinery	6,031	27	24	26
36 Electronics	2,586	23	57	60
37 Transp Equip	1,216	11	37	81
38 Instruments	1,346	9	27	22
39 Misc Manuf	1,208	5	3	2
Total	**30,662**	**282**	**1,322**	**4,286**

Industry	Small		Large	
	% Sites	% Mth	% Sites	% Mth
13 Oil/Gas	86%	1%	14%	99%
20 Food	84%	7%	16%	93%
21 Tobacco	100%	100%	0%	0%
22 Textiles	86%	10%	14%	90%
23 Apparel	100%	95%	0%	5%
24 Lumber	98%	7%	2%	93%
25 Furniture	100%	70%	0%	30%
26 Paper	81%	2%	19%	98%
27 Printing	99%	32%	1%	68%
28 Chemicals	94%	8%	6%	92%
29 Petroleum	57%	0%	43%	100%
30 Rubber/Plastics	96%	24%	4%	76%
31 Leather	99%	20%	1%	80%
32 Stone/Clay/Glass	92%	5%	8%	95%
33 Primary Metals	89%	10%	11%	90%
34 Fab Metals	98%	34%	2%	66%
35 Ind Machinery	100%	51%	0%	49%
36 Electronics	98%	28%	2%	72%
37 Transp Equip	97%	12%	3%	88%
38 Instruments	98%	30%	2%	70%
39 Misc Manuf	100%	67%	0%	33%
Total	**96%**	**6%**	**4%**	**94%**

Source: Utility Billing Data
Large/Small cutoff is 250,000 therms per year

3.6 END USE DETAIL - MANUFACTURING

For the manufacturing industries (SICs 20-39), end-use energy-consumption estimates (at the national level) are available from the Manufacturing Energy Consumption Survey (MECS). MECS is the Energy Information Administration's (EIA's) survey of energy use and related activities by U.S. manufacturers. The survey is administered and compiled by the Census

Bureau. At the time of the analysis, the only end-use data available were from the 1994 MECS. Data from 1998 wee still being processed by the EIA. As discussed in Section 2 of this report, MECS data were applied to California industrial consumption data to provide estimates of end-use energy consumption.

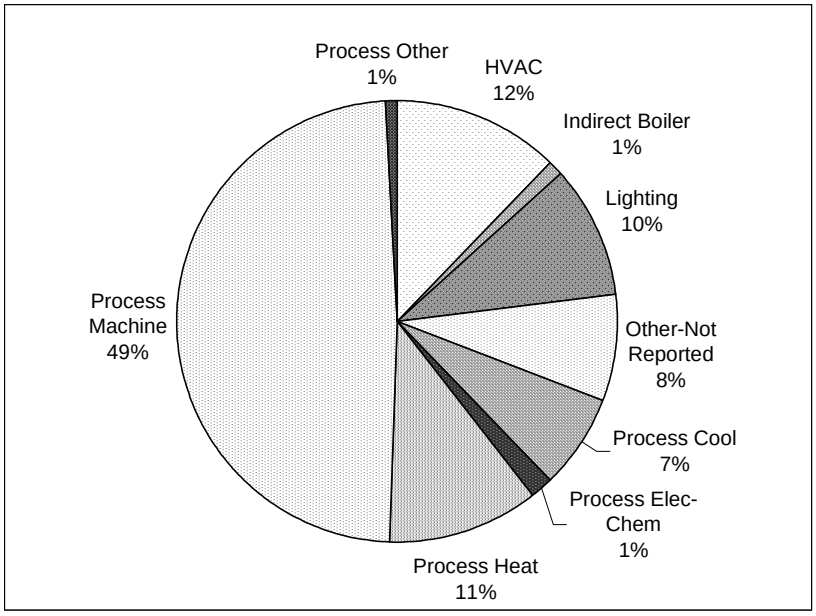
3.6.1 End Use Consumption of Electricity

Figure 3-10 shows the breakdown of electric usage by key end use. The process machine drive component comprises just about half of the electricity consumption in manufacturing and about 70% of process electricity use. The other largest process end uses are process heating (11% of total electricity consumption) and process cooling (7% of consumption). Facility lighting and HVAC usage account for just over 20% of manufacturing electricity use, about evenly split between the two.

Machine Drive Electricity Use

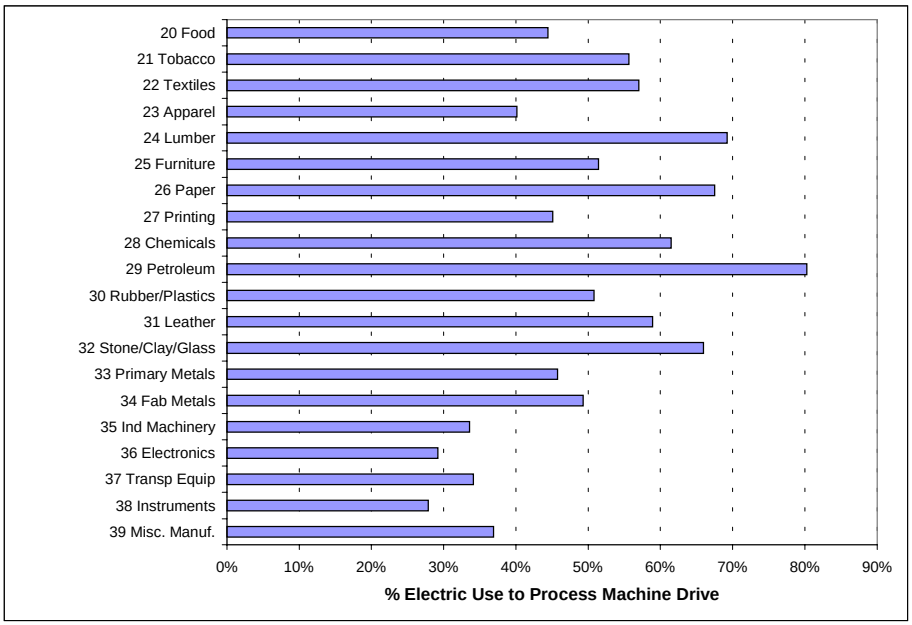
Figure 3-11 shows how the fraction of machine drive energy consumption varies across industry. This amount varies from a high of 80% for Petroleum (SIC 29) to a low of 28% for Instruments (SIC 38).

Figure 3-10
Manufacturing End Use Breakdown of Electric Consumption



Source: MECS and Utility Billing Data

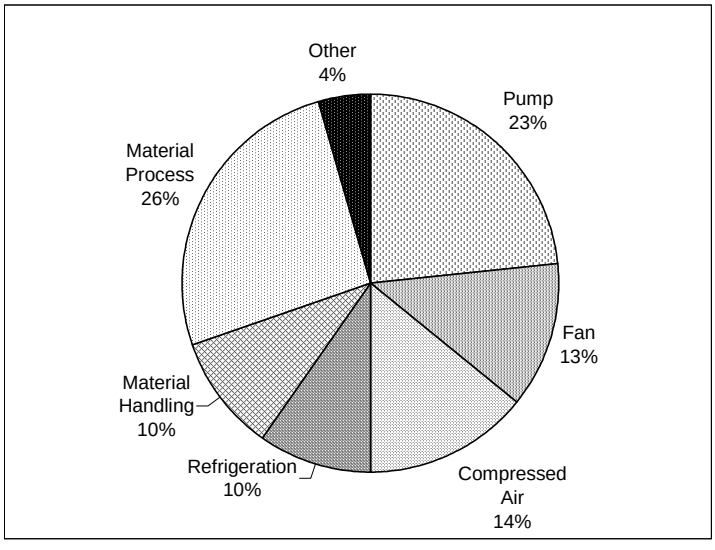
Figure 3-11
Process Machine Drive Component of Electric Consumption



Source: MECS and Utility Billing Data

A more disaggregated motor breakdown is obtained by combining data on the estimated end-use splits with a motor application breakdown from the DOE Industrial Motor Systems Assessment Study. Figure 3-12 shows the results. Pumping and material process applications are the largest electricity-using applications, accounting for about half of the motor load. Other noted applications are split fairly evenly, at between 10% and 15% of motor electricity use each.

Figure 3-12
Breakout of Motor Consumption by Application



Source: MECS, Utility Billing Data, and DOE US Industrial Motor Systems Market Opportunities Assessment Study (XENERGY, December 1999)

Table 3-11, reproduced from the DOE Industrial Motors Assessment Study, shows the distribution of motors by size category. Almost 60% of all motors are 5-horsepower (hp) or less, and about 85% of all motors are 20 hp or less. Table 3-12, also from the DOE motors study, shows the distribution of energy usage by motor size category. Energy usage is shifted to the larger hp motors as they draw much more energy and tend to operate for longer hours.

Table 3-11
Size Distribution of Motors

Motor Horsepower	SIC 28	SIC 26	SIC 33	SIC 29	SIC 20	Other	ALL
1 - 5 hp	42.4%	52.2%	55.0%	32.0%	65.8%	63.9%	58.8%
6 - 20 hp	30.0%	22.3%	26.1%	38.6%	22.6%	25.6%	26.4%
21 - 50 hp	14.5%	13.0%	10.7%	18.9%	6.2%	7.2%	9.1%
51 - 100 hp	5.9%	6.3%	3.5%	6.2%	2.4%	1.9%	2.9%
101 - 200 hp	4.1%	3.1%	2.1%	2.8%	1.8%	1.2%	1.8%
201 - 500 hp	2.2%	2.0%	1.7%	1.0%	0.9%	0.2%	0.7%
501 - 1000 hp	0.6%	0.9%	0.7%	0.3%	0.4%	0.0%	0.2%
1000+ hp	0.4%	0.3%	0.3%	0.2%	0.0%	0.0%	0.1%
All Motor Sizes	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Source: DOE US Industrial Motor Systems Market Opportunities Assessment Study (XENERGY, December 1999)

Table 3-12
Distribution of Energy Usage by Motor Size

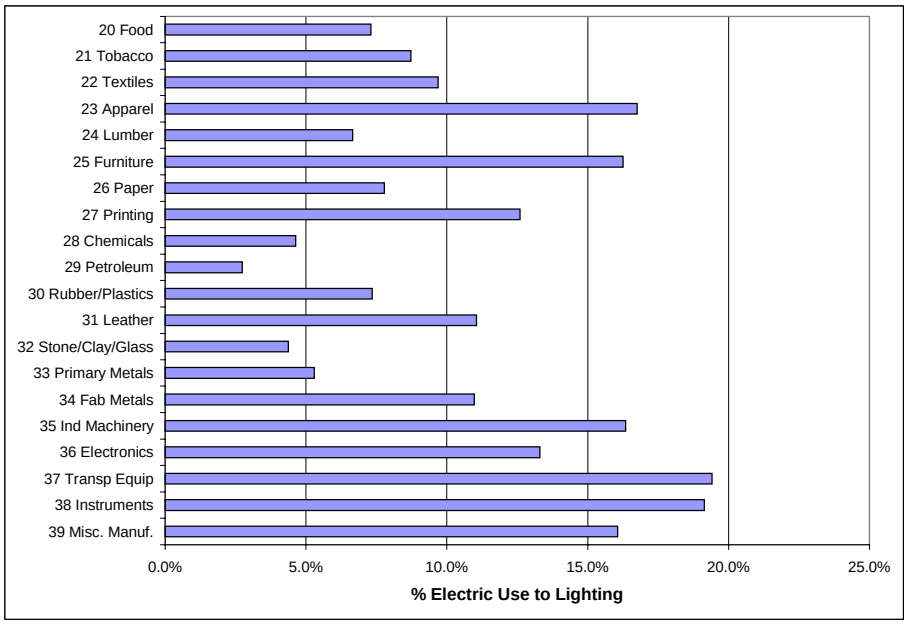
Motor Horsepower	SIC 28	SIC 26	SIC 33	SIC 29	SIC 20	other	ALL
1 - 5 hp	1.6%	1.9%	3.8%	1.0%	9.6%	10.4%	4.8%
6 - 20 hp	6.4%	4.5%	6.7%	5.9%	14.7%	20.7%	10.4%
21 - 50 hp	9.1%	8.8%	9.6%	12.4%	15.6%	19.8%	12.7%
51 - 100 hp	9.3%	13.3%	9.9%	12.2%	13.4%	17.0%	12.7%
101 - 200 hp	14.3%	12.7%	12.4%	13.9%	15.5%	16.9%	14.4%
201 - 500 hp	18.1%	19.6%	19.4%	16.1%	13.6%	9.4%	15.8%
501 - 1000 hp	13.7%	20.6%	19.8%	11.0%	14.7%	5.3%	13.4%
1000+ hp	27.5%	18.5%	18.3%	27.4%	2.9%	0.5%	15.7%
All Motor Sizes	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*

Source: DOE US Industrial Motor Systems Market Opportunities Assessment Study (XENERGY, December 1999)

Lighting

Figure 3-13 shows how the fraction of lighting energy consumption varies across industry. Lighting tends to consume a large fraction of energy use in the “high-tech” industries (SICs 34-38) as well as in the Apparel (SIC 23) and Furniture (SIC 25) industries, owing to the absence of other large energy-consuming equipment in these industries and the need for more task lighting.

Figure 3-13
Lighting Component of Electric Consumption



Source: MECS and Utility Billing Data

Table 3-13 shows the distribution of estimated energy usage by lighting type, based on the 1997 SCE industrial survey. (Standard-efficiency lighting types are highlighted.) Overall, fluorescent tubes are the predominant lighting type. Note that the distribution reflects 1997 survey results and will tend to understate the current penetration of higher-efficiency lighting equipment.

Table 3-13
Distribution of Electricity Usage by Lighting Type

	SIC								
Lighting Type	**20**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**30**
Incandescent	6.2%	5.2%	6.2%	5.9%	4.6%	4.3%	1.5%	12.1%	2.0%
Standard Fluorescent	64.6%	69.2%	77.0%	86.9%	75.1%	54.3%	80.7%	68.6%	69.6%
High Efficiency Fluorescent	11.7%	17.9%	8.8%	2.7%	7.9%	25.6%	15.3%	8.8%	10.6%
Mercury Vapor	1.4%	0.0%	2.3%	0.7%	0.9%	0.8%	0.1%	2.4%	1.5%
Metal Halide	10.4%	5.3%	0.5%	1.1%	4.2%	5.3%	0.5%	3.6%	10.8%
High Pressure Sodium	4.6%	0.1%	0.2%	1.4%	0.0%	6.5%	0.1%	1.7%	3.4%
Low Pressure Sodium	0.0%	0.0%	0.0%	0.3%	0.0%	0.2%	0.1%	0.5%	0.1%
Skylights	1.0%	1.9%	2.3%	1.0%	7.3%	3.1%	1.9%	2.1%	2.0%
Other	0.0%	0.4%	2.7%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%

	SIC								
Lighting Type	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**TOTAL**
Incandescent	17.8%	7.1%	4.2%	4.4%	2.0%	3.5%	2.8%	0.5%	4.3%
Standard Fluorescent	59.9%	60.5%	77.1%	76.0%	77.5%	80.1%	79.4%	86.2%	76.1%
High Efficiency Fluorescent	1.8%	5.7%	7.6%	10.7%	12.7%	9.0%	11.2%	7.2%	10.2%
Mercury Vapor	12.9%	6.7%	2.7%	1.6%	0.7%	0.9%	1.4%	0.1%	1.6%
Metal Halide	1.0%	10.7%	3.8%	3.5%	2.9%	2.8%	2.9%	1.4%	3.4%
High Pressure Sodium	6.2%	5.6%	1.9%	1.6%	1.2%	2.2%	1.2%	3.0%	1.8%
Low Pressure Sodium	0.1%	0.3%	0.2%	0.2%	0.0%	0.3%	0.1%	0.0%	0.1%
Skylights	0.2%	3.4%	2.6%	2.0%	2.8%	1.4%	1.0%	0.9%	2.1%
Other	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.7%	0.3%

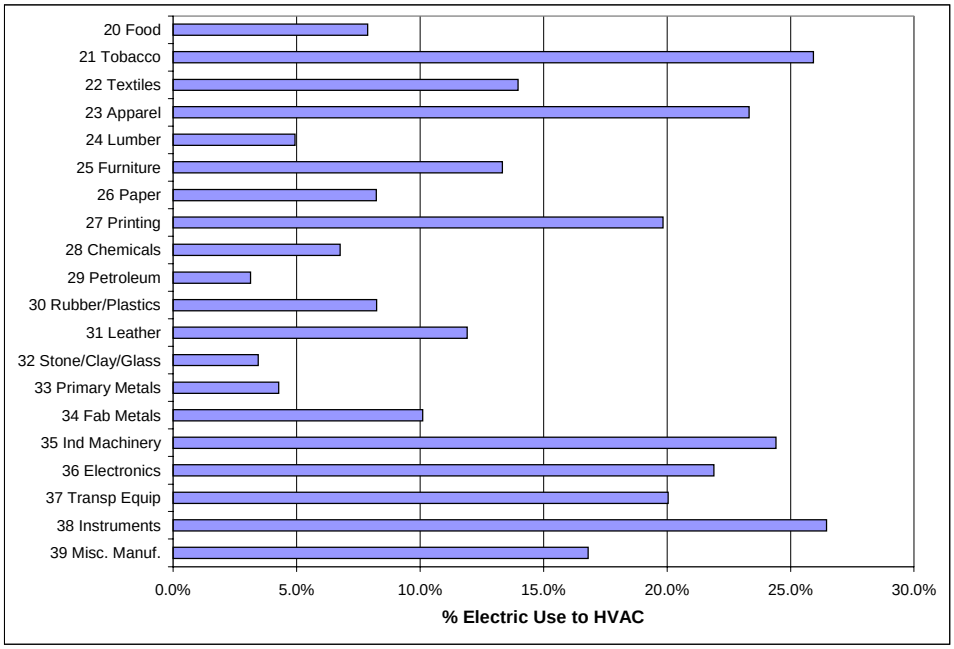
Source: SCE Industrial Survey

HVAC

Figure 3-14 shows how the fraction of HVAC energy consumption varies across industry. Similar to lighting, HVAC tends to consume a large fraction of energy use in the "high-tech" industries (SICs 34-38). In addition to the absence of large process loads, the need to maintain consistent, specific temperatures for the high-tech manufacturing processes contributes to the higher relative HVAC loads.

Table 3-15 shows the distribution of electricity use by cooling equipment type, as well as estimates of the percent of HVAC energy usage that is attributable to cooling. These data are taken directly from the 1997 SCE industrial survey (and exclude SIC 29, which was not surveyed). Overall, packaged air conditioning units were estimated to account for the most cooling electricity use, followed by chillers.

Table 3-14
HVAC Component of Electric Consumption



Source: MECS and Utility Billing Data

Table 3-15
Cooling Electricity Use by Equipment Type

	SIC								
	20	22	23	24	25	26	27	28	30
% HVAC to Cooling	51%	44%	100%	94%	96%	79%	92%	26%	92%
Primary Cooling Type									
Chiller	25%	23%	28%	26%	23%	29%	28%	19%	34%
Packge Unit	38%	36%	12%	26%	29%	52%	38%	66%	54%
Gas Absorb.	0%	0%	0%	0%	3%	0%	2%	4%	0%
Evap Cooler	18%	0%	8%	11%	3%	1%	5%	2%	7%
Cold Storage	17%	3%	1%	0%	0%	0%	0%	0%	1%
Other	2%	2%	13%	4%	8%	0%	6%	2%	5%

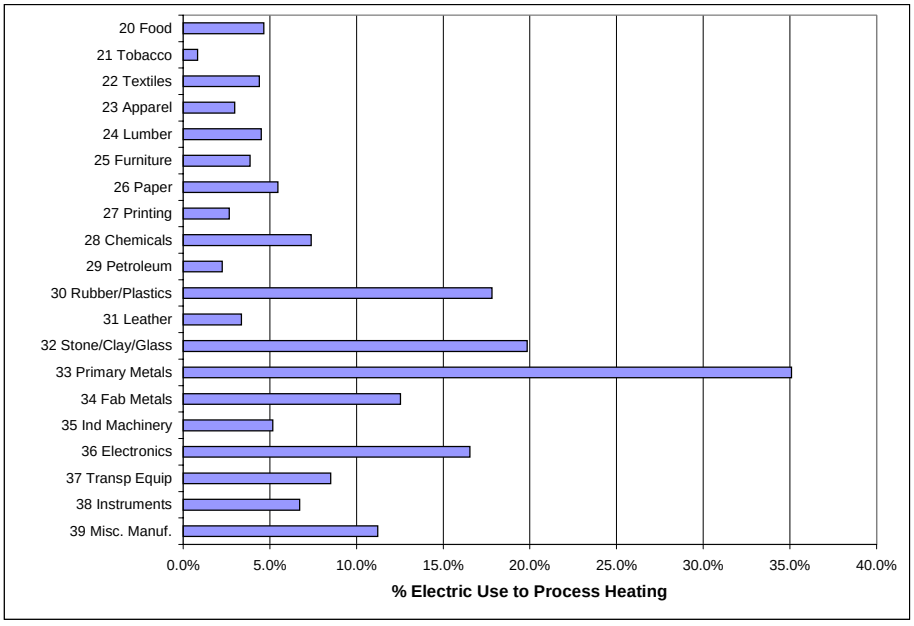
	SIC								
	32	33	34	35	36	37	38	39	TOTAL
% HVAC to Cooling	78%	65%	93%	37%	71%	100%	26%	100%	58%
Primary Cooling Type									
Chiller	26%	20%	18%	19%	32%	18%	21%	15%	23%
Packge Unit	49%	53%	41%	33%	57%	36%	60%	37%	38%
Gas Absorb.	2%	0%	1%	1%	2%	2%	0%	3%	1%
Evap Cooler	2%	5%	4%	9%	7%	2%	4%	14%	6%
Cold Storage	10%	0%	0%	0%	1%	0%	2%	0%	1%
Other	11%	4%	7%	5%	0%	2%	1%	8%	5%

Source: SCE Industrial Survey

Electric Process Heating

Figure 3-14 shows how the fraction of process heating electricity use varies by industry. The large process heating fraction for Primary Metals (SIC 33) is largely due to electric arc furnaces and ladle metallurgical furnaces in the steel industry. Other key electric process heating applications include: cooking, melting (metals, glass, plastics), drying and curing (food, lumber, paper, textiles, chemicals, plastics, metals), and direct product heating (metals, chemicals, petroleum, electronics).

Figure 3-14
Process Heating Component of Electricity Consumption

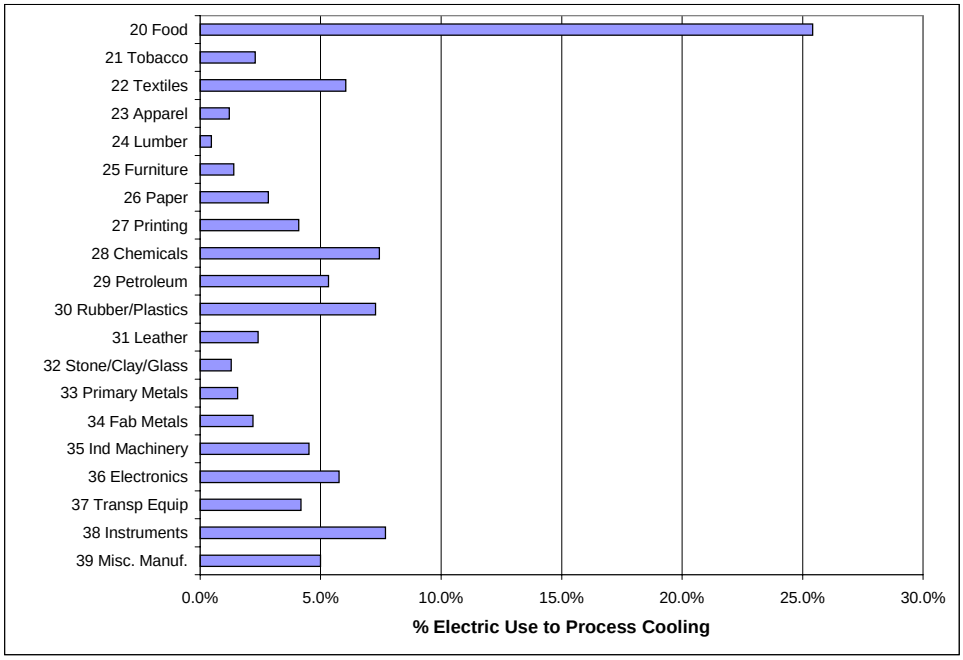


Source: MECS and Utility Billing Data

Process Cooling

Figure 3-15 shows how the fraction of process cooling electricity use varies by industry. The large process cooling fraction for Food Processing (SIC 20) is the result of large refrigeration and freezing requirements. Other industries require electricity to cool materials at various stages of the production process.

Figure 3-15
Process Cooling Component of Electricity Consumption



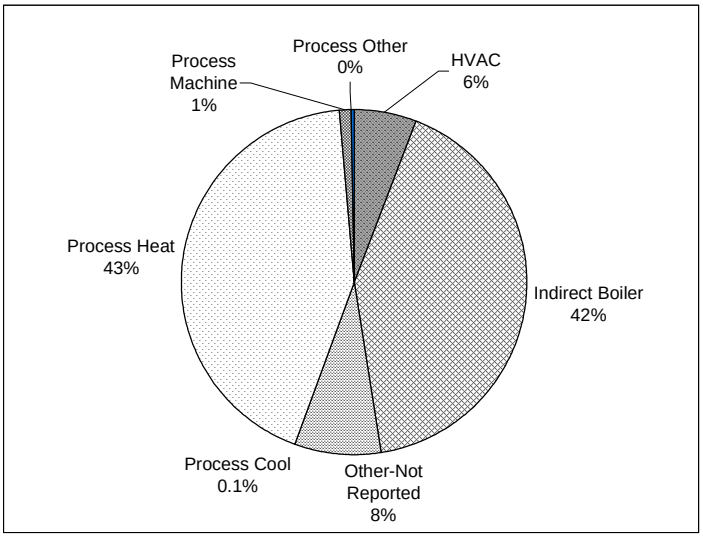
Source: MECS and Utility Billing Data

3.6.2 End Use Consumption of Natural Gas

Figure 3-16 shows the breakdown of natural gas usage by key end use. The consumption percentages for the end-use categories shown in the figure are slightly overstated because feedstock uses of natural gas (mostly in the Chemicals industry) are not factored in to the allocation. As shown, most of the gas used in manufacturing goes to direct process heating and indirect boiler fuel (for the production of steam and hot water).

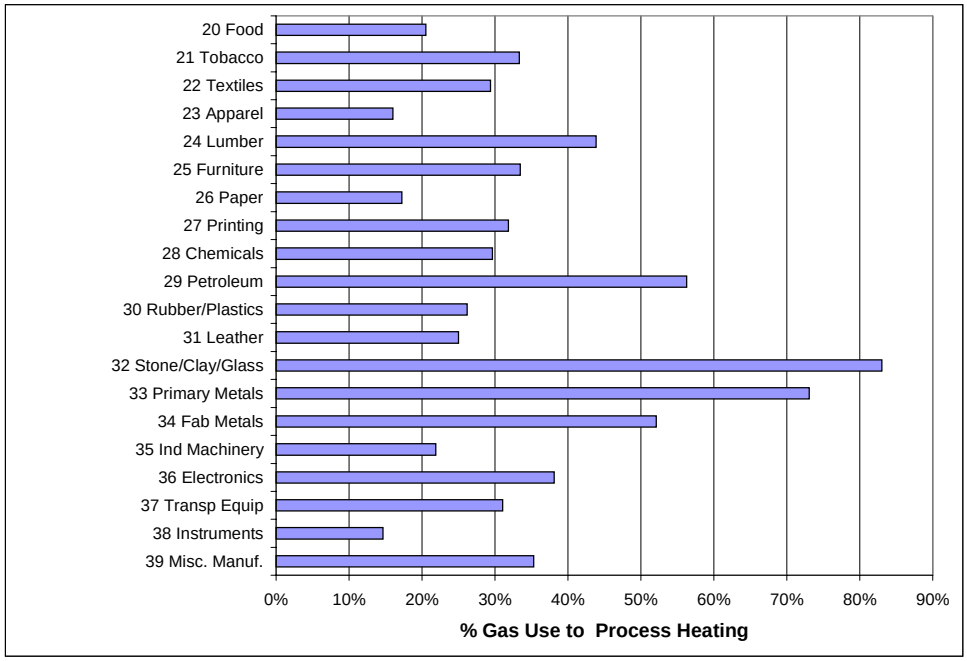
Figures 13 and 14 show the variation in process heat and indirect boiler fuel usage across the manufacturing industries. Process heating is most predominant in Petroleum Refining (SIC 29), Stone, Clay, and Glass (SIC 32), Primary Metals (SIC 33), and Fabricated Metals (SIC 34). Of the larger gas consuming industries, boiler fuel usage is most predominant in Food Processing (SIC 20), Paper (SIC 26), and Chemicals (SIC28).

Figure 3-16
Manufacturing End Use Breakdown of Natural Gas Consumption



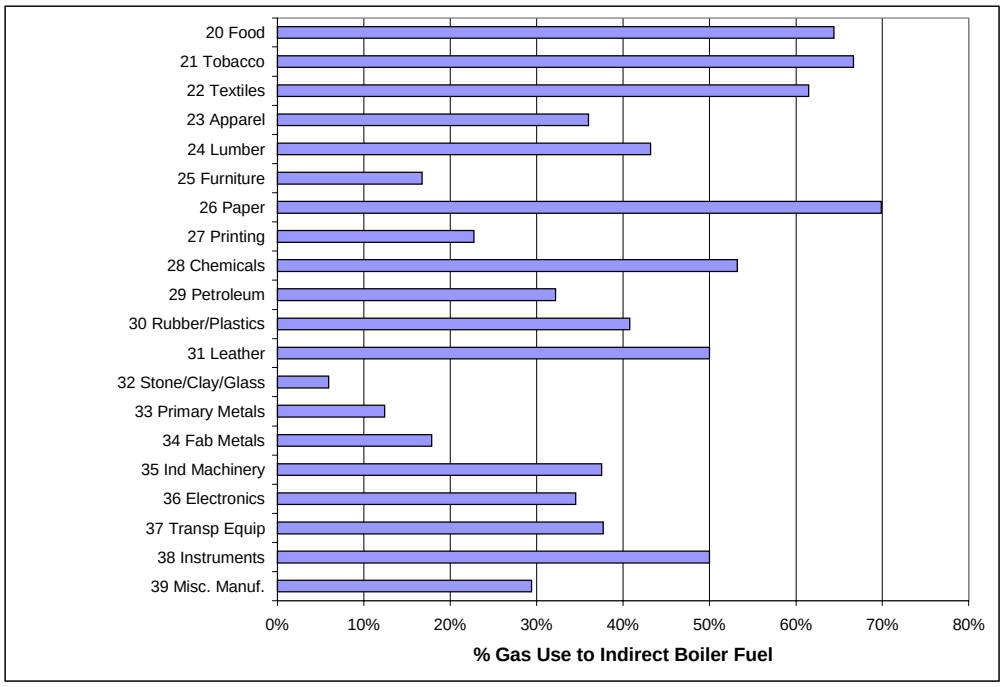
Source: MECS and Utility Billing Data

Figure 3-17
Process Heat Component of Natural Gas Consumption



Source: MECS and Utility Billing Data

Figure 3-18
Indirect Boiler Fuel Component of Natural Gas Consumption



Source: MECS and Utility Billing Data

Boilers are used to produce steam and hot water that are used in a variety of applications, including cooking, cleaning and sanitation, process heating, concentration and distillation of liquids, and to drive mechanical equipment.

Table 3-16 identifies a number of industrial process heating applications. Key process heating applications include cooking, melting, drying, curing, and materials heating. Direct process heating equipment includes furnaces, ovens, heaters, reactors, kilns, incinerators, and dryers.

Table 3-16
Major Process Heating Operations

Metal Melting
- Steel making
- Iron and steel melting
- Non-ferrous melting

Metal Heating
- Steel soaking, reheat, ladle preheating
- Forging
- Non-ferrous heating

Metal Heat Treating
- Annealing
- Stress relief
- Tempering
- Solution heat treating
- Aging
- Precipitation hardening

Curing and Forming
- Glass annealing, tempering, forming
- Plastics fabrication
- Gypsum production

Fluid Heating
- Oil and natural gas production
- Chemical/petroleum feedstock preheating
- Distillation, visbreaking, hydrotreating, hydrocracking, delayed coking

Bonding
- Sintering, brazing

Drying
- Surface film drying
- Rubber, plastic, wood, glass products drying
- Coal drying
- Food processing
- Animal food processing

Calcining
- Cement, lime, soda ash
- Alumina, gypsum

Clay Firing
- Structural products
- Refractories

Agglomeration
- Iron, lead, zinc

Smelting
- Iron, copper, lead

Non-Metallic Materials Melting
- Glass

Other Heating
- Ore roasting
- Textile manufacturing
- Food production
- Aluminum anode baking

4 ENERGY EFFICIENCY RESULTS

This section provides information on energy efficiency in the industrial sector. An important component of this section is the development of energy-efficiency savings potential estimates for primary industrial end uses: machine drive systems, lighting, HVAC, steam systems, and process heating. Additionally, information from utility studies and other sources is presented to characterize energy-efficiency opportunities and barriers.

4.1 MACHINE DRIVE SYSTEMS

The DOE Industrial Motor Systems Market Opportunities Assessment Study (DOE Motors Study, completed in 1998, is the primary data source for most of the information contained in this subsection. This study was conducted through DOE's Motor Challenge Program. The first part of this subsection presents key energy-efficiency measures that apply to machine drive systems. Following the measure descriptions are energy-efficiency potential estimates, developed by applying savings fractions from the DOE Motors Study to estimates of machine drive energy usage discussed in Section 3.

Table 4-1 shows basic machine drive energy-efficiency measures. Measures address motor efficiency upgrades and system efficiency measures and were developed from a literature review and interviews with industry experts. A brief description of each measure is provided.

Table 4-1
Machine Drive Energy-Efficiency Measures

Motor Efficiency Upgrade	
Efficient replacement	Replace motor currently in use with higher efficiency motor.
Improve rewinding practices	Follow rewinding protocols adopted by the Electrical Apparatus Service Association (EASA). Avoid rewind practices known to contribute to efficiency degradation such as the use of high temperatures to soften wire.
System Efficiency Measures	
Reduce system load requirements	This category encompasses a wide range of strategies such as widening pipe diameters to reduce resistance, straightening ducts, leveling process flows over time to reduce peak loads, and eliminating unnecessary by-passes. These strategies share a common result in reducing and/or leveling loads on motors, which open up opportunities for use of smaller or fewer motors in the system. Case studies of these kinds of projects report reductions of 5 percent to 60 percent of system energy.
Reduce or control motor speed	Reduction of speed to match load or use of ASDs to match speed to fluctuating loads can save a great deal of system energy due to the exponential relationship between shaft speed and energy. Case studies of ASD installations or mechanical speed reductions to replace throttling controls have found system savings in the range of 30 percent to 80 percent.
Match component size to load	Frequently motor systems are sized to accommodate the peak load expected for the system, with little or no allowance for the operation of the process at partial load. Various schemes can be used to serve part load while saving energy. These include staging of equipment, automatic shutdown, parallel systems, and downsizing. Estimated savings from these kinds of projects range from 5 percent to 30 percent.
Upgrade component efficiency	For most types of turbo machinery, relatively small savings are available by upgrading the inherent efficiency of components such as pumps, compressors, and auxiliaries. Analysts suggest that available savings range from 2 percent to 10 percent of system energy.
Maintenance	For some kinds of systems, in particular air compressors, conscientious maintenance can yield significant system savings due to plugging leaks and maintaining system balances. Savings from these measures can range from 2 percent to 10 percent of system energy.
Motor downsizing	This measure reduces the size of the motor to better match load within the motor's efficient operating range. It is included in System Efficiency Measures because it involves the balancing of system components with load rather than upgrading the efficiency of the motor itself.

Source: DOE US Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999)

Table 4-2 shows more detail on pumping system energy efficiency measures. The measures involving reduction in overall system requirements have the highest applicability levels, in the 40% to 60% range. Measures to control pump speed are associated with the highest savings potential.

Table 4-2
Pumping System Energy-Efficiency Measures

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Reduce Overall System Requirements	
Equalize flow over production cycle using holding tanks.	Easton Consultants report suggests savings are in the 10–20 percent range.
Eliminate bypass loops and other unnecessary flows.	Easton report suggests savings are in the 10–20 percent range.
Increase piping diameter to reduce friction.	The retrofit of increasing pipe diameter has been done in 9 percent of facilities according to the practices survey. This is an expensive measure but the Easton report suggests savings are in the 5–20 percent range.
Reduce "safety margins" in design system capacity.	This measure is applicable to all pumps. Easton report suggest savings are in the 5–10 percent range.
Match Pump Size to Load	
Install parallel systems for highly variable loads.	According to the practices survey 5 percent of facilities have implemented parallel pumps. Easton report suggests savings are in the 10–50 percent range. Other experts report that the "best practice" for variable loads is to install a larger pump with speed control to obtain similar savings.
Reduce pump size to better fit load.	According to the practices survey 5 percent of facilities have implemented smaller pumps. Easton report, supported by other experts, suggests that pumps are routinely 15–25 percent oversized.
Reduce or control pump speed	
Reduce speed for fixed loads: trim impeller, lower gear ratios.	According to the inventory data, 82 percent of pumps have load modulation recorded as "none." Performance optimization studies cite savings as high as 75 percent in the food processing, paper and petrochemical industries.
Replace throttling valves with speed controls to meet variable loads.	According to the inventory data, 6 percent of pumps have load modulation recorded as "throttle valve," which seems low according to industry experts. Case studies of ASD installations show savings in the range of 30 to 80 percent. This measure applies to circulating pump systems, not systems with static heads.
Improve Pump Components	
Replace typical pump with most efficient model, or one with an efficient operating point better suited to the process flows.	According to the inventory data, 16 percent of pumps are greater than 20 years old, many of which can be replaced with more efficient models that better match the process operating point. According to industry experts, the problem is not necessarily the age of the pump but the fact that the process may have changed over time and that the operating point does not match the best efficiency point of the pump. Easton report notes pump efficiency may degrade 10–25 percent before replacement. Newer pumps are 2–5 percent more efficient. ACEEE cites savings in the 2–10 percent
Replace belt drives with direct coupling.	According to the inventory data, 4 percent of pumps have drive type as V-belt, many of which can be replaced with direct couplings. Savings are on the order of 1 percent.
Operation and Maintenance	
Replace worn impellers, especially in caustic or semi-solid applications. Inspect and repair bearings, lip seals, packings and other	According to the Hydraulic Institute, pump efficiency degrades from 1 to 6 points for impellers less than maximum diameter and with increased wear ring clearances. Pumps less than 15 HP are particularly sensitive to reductions in pump efficiency due to mechanical losses.

Source: DOE US Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999)

Table 4-3 presents more detail on fan system energy-efficiency measures. Operations and maintenance measures are estimated to have the highest applicability. It appears that 25% to 60% of all industrial fan systems could benefit from increased maintenance. Similar to pumping systems, the largest energy savings potential is associated with measures that reduce or control fan speeds, using equipment such as adjustable speed drives.

Table 4-3
Fan System Energy-Efficiency Measures

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Reduce Overall System Requirements	
Reduce "system effect" through better inlet and outlet design.	Easton report states that reducing system effect can reduce energy consumption by 25 percent.
Reduce fan oversizing.	Easton report states that cost pressures limit oversizing, but that reducing oversizing can reduce consumption by 1–5 percent. Industry experts indicate that most have some degree of oversizing. It is often easier to control speed or use a slower speed motor than to replace fan with smaller size.
Reduce or control fan speed	
Replace inlet or outlet dampers and variable inlet vane with electronic speed controls to meet variable loads.	According to industry experts, there are about 10 times more fans with inlet damper than outlet damper, both of which allow some adjustment in flow. Performance optimization studies estimate savings in the range of 14–49 percent when retrofitting with an ASD. Higher savings are achieved with outlet damper but there are fewer applications.
Improve Fan Components	
Replace Standard V-Belt with Cogged V-Belt.	According to the inventory data, half of fans have "V-belt" drive type. According to Easton report, 2/3 of V-belts are standard and can be upgraded to cog belts. Standard V-belt efficiency ranges from 90–97 percent while cogged V-belt efficiencies are 94–98 percent.
Replace fan with more efficient model.	According to the Easton report, although fan efficiencies vary significantly across impeller types, there are limited opportunities to trade up to more efficient models.
Operation and Maintenance	
Improve O&M practice such as tightening belts, cleaning fans and changing filters regularly.	These practices can be applied to all fans with savings ranging from 2 to 5 percent.

Source: DOE US Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999)

Additional detail on compressed air system measures in presented in Table 4-4. Operation and maintenance measures have both the highest applicability, at 50% to 85% of all systems, and overall savings potential.

As noted in Tables 4-3 through 4-5 for pumping, fan, and compressed air systems, improved motor control measures offer significant energy savings potential. Adjustable-speed drives (ASDs), also referred to as variable-speed drives, variable-frequency drives, and adjustable-frequency drives, are often used to provide this control. ASDs offer two major benefits to industrial customers: enhanced process control and energy savings. While ASDs are one of the most energy-efficient ways to control speeds of motors that face fluctuation loads, they are not cost-effective in all variable-load motor system applications. Table 4-5 lists important factors that must be considered in the cost-effective application of ASDs.

Table 4-6 shows the saturation of ASDs in the U.S., based on the DOE Motors Assessment Study. The first half of the table shows that saturations are highest in "Other" motor systems, but that savings are more concentrated in pumping, fan, and compressed air systems. The lower part of the table shows that ASD saturations are highest in the smaller horsepower classes. In these cases, ASDs are primarily used to enhance control over production processes and not to save energy. Overall, the saturation of ASDs is fairly low at 9% of motor systems, accounting for 4% of motor system energy use.

Table 4-4
Compressed Air System Energy-Efficiency Measures

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Reduce Overall System Requirements	
Reduce overall system pressure through better system design and better ancillary components (filters and dryers).	According to the practices survey 15 percent of facilities have reconfigured piping and filters in their compressor systems. Easton report estimates savings in the range of 4–6 percent.
Reduce system demand by eliminating poor applications of compressed air.	The misapplication of compressed air for uses such as blowing, cooling, cleaning or to move parts, etc. is a wasteful practice. Compressed air can be replaced with blowers, fans or electric motors with substantial energy savings. Industry experts estimate that discontinuing these practices as well as shutting off air flow to equipment not in use can save as much as 20 percent.
Segment system and provide satellite or booster compressors or storage when remote locations have special requirements such as higher pressures, cleaner air, or short term high volumes.	While decentralizing compressors does not always save energy, some facilities with large compressors serving all departments in a relatively large area (in terms of floorspace) may benefit from segmenting the system. ACEEE report cites a case study in a Ford plant in which savings of 80 percent were achieved but industry experts point out that this is not typical and savings are closer to about 5 percent.
Improve supply conditions; use outside air.	Assume half of all compressors use room air for supply. Easton report estimates savings for this measure in the range of 4–6 percent. Industry experts note that this measure may increase O&M.
Match Compressor Size to Load	
Size compressors for efficient trimming.	Stage compressors so that the base load is supplied by compressors running at design load with a trim compressor (reciprocating or rotary screw type) to supply the variable load. Industry experts estimate savings of 5 percent.
Compressor Control	
Install standard part load controls which include automation and storage.	This can be applied to most compressors. ACEEE cites savings in the 3–7 percent range.
Install microprocessor controls on compressor system.	These controls tighten the deadband from 10 psi to 2 psi. Savings in the 2–4 percent range.
Use parallel compressors and install multi-unit controls to reduce compressor part loading.	According to the practices survey 14 percent of facilities indicated using parallel compressors and 7 percent of facilities indicated the installation of multi-unit controls. Unloading controls were recommended for 6 of 7 BPA case studies using AIRMaster, with savings ranging from 3 to 33 percent. Performance optimization studies calculate savings in the range of 11–16 percent. Easton study cites savings of 10–15 percent. Industry experts point out that these savings can only be achieved in facilities having several compressors, not just two or three.
Install ASDs for rotary compressors.	The inventory data indicates that 97 percent of compressors do not have ASDs. Easton estimates the proportion of rotary compressors is 72 percent. Industry experts point out that the opportunities may not be as large as these saturations suggest because there are often better methods to manage the load (sizing and trimming). For rotary compressors with variable loads ASDs offer better part load efficiency than inlet valve modulation. Savings are on the order of 10 percent according to industry experts.
Improve Compressor Components	
Replace older single stage reciprocating compressors and symmetrical screw compressors with more efficient model.	According to the inventory data, 6 percent of compressors are greater than 20 years old. Easton report cites a 10–20 percent efficiency variation across compressor types. Industry experts note that some of the older equipment, such as double acting reciprocating compressors, are very efficient.
Operation and Maintenance	
Reduce leaks by instituting an ongoing program of system maintenance on regulators, quick connect fittings, tubing, pipes and other points of connection.	According to the DOE motor practices survey 38 percent of facilities indicated they had fixed leaks in the past 2 years. Easton report estimates savings in the range of 15–25 percent. An ACEEE report states leaks are 15 percent of compressor load. All 7 BPA cases studies using AIRMaster (conducted in 1997) recommend reducing leaks with estimated savings ranging from 2.7 to 59 percent.
Improve maintenance on compressor: e.g., valves for reciprocating compressors and intercoolers for centrifugal	Industry experts estimate savings in the range of 2–5 percent.
Change compressor filters and point of use filters regularly to reduce pressure drops.	Easton report cites that improved ancillary equipment saves 4–6 percent. Industry experts estimate that replacing point of use filters saves 3 percent and compressor filters 1–2 percent.

Source: DOE US Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999)

Table 4-5
Screening Factors of ASD Applicability

Characteristic	Screening Factor for ASD Applicability
Induction Motors	Only AC motors use an ASD (more specifically an adjustable frequency drive) .
Horsepower	• >15 HP the payback is usually too long. • 15 to 30 HP are good candidates. • >30 HP usually excellent candidates for ASDs
Operating Hours	Relatively high operating hours (>2000 per year).
Type of Load	Centrifugal load rather than a static load or constant volume displacement.
Load Fluctuation	Load variability greater than 30%, e.g. a load that varies from 60% to 90%.
Percentage of Time at Reduced Load	The loading on a motor may vary a great deal but if the variation occurs for only a short period of time and it is running most of the time at a constant load, a drive is usually not justified.
Existing Load Modulation Equipment	• *Throttle Valve*: excellent applicability of ASDs. • *Outlet Damper*: good applicability of ASDs. • *Inlet Vane*: depends on the type of control. Iris type is better to retrofit with ASD than the parallel box type. • *Multi Speed Motor*: with a throttle valve it is also indicated. • *Eddy Current Clutch*: applicability fair but it may not bay back. • *Adjustable Speed Gearbox*: direct load measurements needed. • *None*: direct load measurements needed.

Source: DOE US Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999)

Table 4-6
Saturations of ASDs by Application and Motor Size

	Motor Systems with ASDs	Energy in Systems with ASDs
Application	**% of Total**	**% of Total**
Pump	3%	2.9%
Fan	7%	8.3%
Compressed Air	2%	3.7%
Other	11%	4.3%
All Applications	9%	4.4%

	Motor Systems with ASDs	Energy in Systems with ASDs
Horsepower Class	**% of Total**	**% of Total**
< 1 hp	-	-
1 - 5 hp	11%	13%
6 - 20 hp	8%	7%
21 - 50 hp	4%	3%
51 - 100 hp	4%	4%
101 - 200 hp	5%	4%
201 - 500 hp	2%	2%
501 - 1000 hp	3%	4%
1000+ hp	6%	5%
All Motor Sizes	9%	4%

Source: DOE US Industrial Motor Systems Market Opportunities Assessment (XENERGY, December 1999)

Machine drive energy-efficiency potential estimates for California were developed by applying savings fractions from the DOE Motors Study to application-level energy consumption estimates

that were presented in Section 3 of this report. The analysis was conducted at the 2-digit SIC code level. The savings fractions from the DOE Motors Study were developed using standard engineering calculations for motor efficiency measures and expert opinion and case studies on measure applicability and energy savings for motor systems measures. The opinions of industry experts, primarily consulting engineers, manufacturers' technical staff, and industry association representatives, were used to estimate the percentage of systems to which various measures in the major application categories could be cost-effectively applied, using a 3-year payback criterion. Their opinions were also used to estimate the average savings these measures could achieve, in terms of percentage of initial system energy use. Similar information was gathered from case studies and other documents.

Machine drive energy-efficiency potential estimates for California are summarized in Table 4-7. This potential represents savings that could be achieved from the application of measures identified above in situations where the likely payback period for investment in these measures is roughly 3 years or less. In the top part of the table, savings potential from the application of systems measures is shown for each key machine drive system. In the bottom half of the table, saving potential for motor efficiency measures that apply to all systems is shown.

Table 4-7
Machine Drive Energy-Efficiency Potential

Application / Measure	Energy Use (GWh)	Savings Potential (GWh)	Savings %
Fan System	2,338	118	5.0%
Pump System	4,237	803	19.0%
Compressed Air Systems	2,703	461	17.0%
Other Process Systems	7,808	154	2.0%
All Systems	17,086	1,535	9.0%
Motor Efficiency Measures (Applies to All System Types)			
Efficiency Upgrades	17,086	581	3.4%
Motor Downsizing	17,086	205	1.2%
Replace vs. Rewind	17,086	142	0.8%
All Motor Efficiency Measures	17,086	928	5.4%
Motor Totals	17,086	2,463	14.4%

It appears that about 14% of total machine drive electricity usage could be saved through the cost-effective application of system and motor efficiency measures, a savings of over 2,000 GWh per year. Nine percent of the potential savings could be achieved by utilizing system efficiency measures. Pumping system measures show the largest savings potential. Motor efficiency measures account for a savings potential of about 5.4%. Motor efficiency upgrades, commonly viewed as the key machine drive efficiency measure, contribute about one-fourth of the total potential.

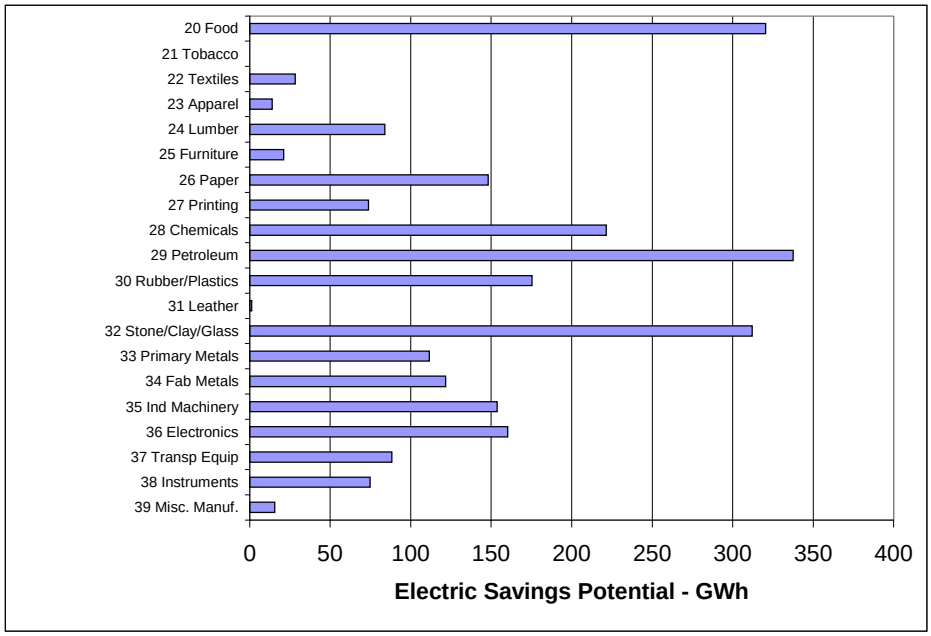
Table 4-8 breaks out machine drive savings potential by industrial category, and Figure 4-1 presents total machine drive savings potential graphically. Key industries to consider for machine drive energy savings include Food Processing (SIC 20), Chemicals (SIC 28), Petroleum Refining (SIC 29), and Stone, Clay, and Glass (SIC 32). Pumping system measures contribute most to the Petroleum energy-efficiency potential estimates, while potential savings for Food,

Chemicals, and Stone, Clay, and Glass are split more evenly between pumping, compressed air, and motor efficiency upgrades.

Table 4-8
Summary of Machine Drive Potential by Industry and Application - GWh

Industry Category	Fan System	Pump System	Compressed Air Systems	Other Process Systems	Efficiency Upgrade	Motor Downsizing	Replace vs. Rewind	All Systems	As % of Total Energy
20 Food	11	90	45	35	85	32	23	320	11.8%
21 Tobacco	-	-	-	-	-	-	-	-	-
22 Textiles	1	8	5	2	8	3	2	28	14.0%
23 Apparel	1	4	3	1	3	1	1	14	14.0%
24 Lumber	4	22	30	8	9	6	5	84	14.8%
25 Furniture	1	6	4	1	6	2	1	21	14.1%
26 Paper	12	68	13	9	30	7	10	148	13.8%
27 Printing	4	18	12	7	21	9	3	74	15.6%
28 Chemicals	9	75	68	9	36	11	14	222	15.4%
29 Petroleum	9	202	44	5	49	11	16	338	19.8%
30 Rubber/Plastics	10	50	31	14	46	12	12	175	13.3%
31 Leather	0	0	0	0	0	0	0	1	11.2%
32 Stone/Clay/Glass	15	77	68	17	91	31	14	312	15.5%
33 Primary Metals	8	17	30	11	30	8	9	112	11.8%
34 Fab Metals	6	30	28	8	28	16	6	122	15.3%
35 Ind Machinery	7	38	26	12	43	21	7	154	15.4%
36 Electronics	9	48	24	4	50	16	10	160	12.8%
37 Transportation Equip	5	26	17	5	23	6	6	88	13.1%
38 Instruments	4	20	13	6	18	10	3	75	14.4%
39 Misc. Manuf.	1	5	1	1	4	2	1	15	12.2%
All Industry Groups	118	803	461	154	581	205	142	2,463	**14.4%**

Figure 4-1
Machine Drive Energy-Efficiency Potential by Industry



4.2 LIGHTING

End-use lighting energy consumption was developed by industry category by applying MECS end-use consumption splits to utility billing data. Fixture-type energy use distributions from the SCE 1997 Industrial survey were then used to assign total lighting energy use (by industry category) to standard- and high-efficiency technologies. Savings fractions were developed assuming standard-efficiency equipment would be replaced with the most typical high-efficiency equipment: incandescent fixtures replaced by CFLs, fluorescent tube fixtures replaced by T-8 fixtures with electronic ballast, and mercury vapor fixtures replaced replace by high-pressure sodium fixtures. Lighting savings potential estimates were then developed by multiplying total lighting consumption by fixture-type fractions and by savings fractions. To partially adjust for lighting efficiency improvements between 1997 and 2001, the fraction of standard fluorescent/standard ballast lighting was reduced by 0.11, and the T-8/electronic ballast fraction was increased by 0.11. These adjustments were based on a review of utility program accomplishments and conservative estimates of naturally occurring installations.

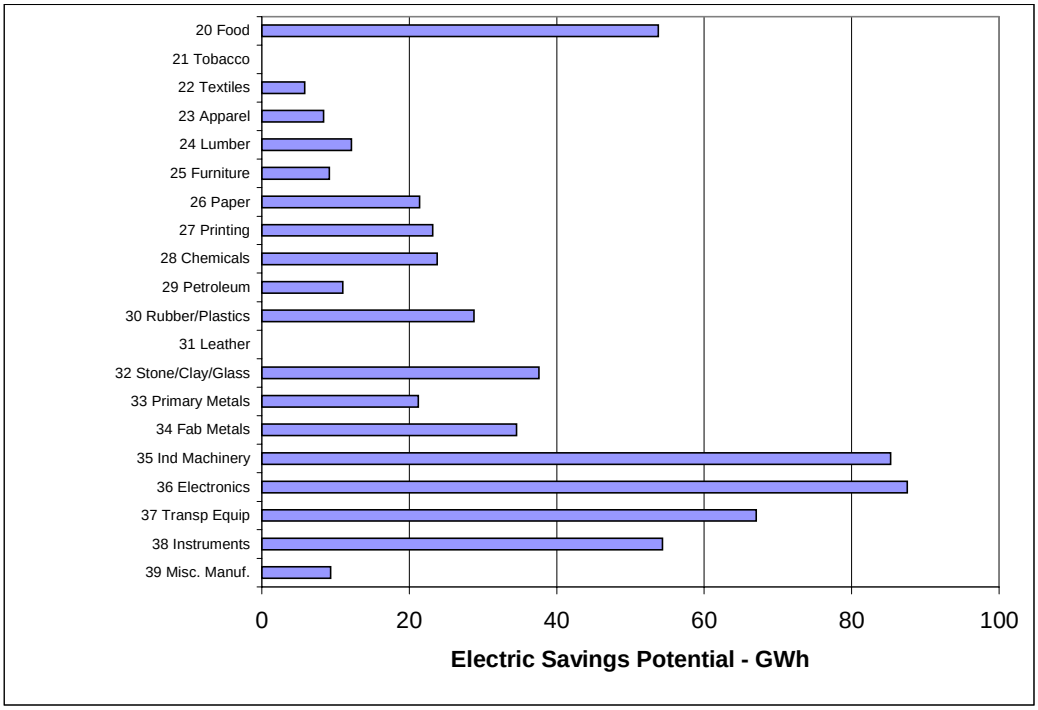
Lighting energy-efficiency potential estimates are summarized in Table 4-9, and potential estimates by industry category are shown in Figure 4-2. While conversion of standard fluorescent fixtures to T8 fixtures is the major sources of potential savings for all industry categories, incandescent-to-CFL conversions contribute 25% or more of the savings potential for four industry groups: Food (SIC 2), Chemicals (SIC 28), Stone, Clay, and Glass (SIC 32), and Primary Metals (SIC 33).

Table 4-9
Lighting Energy-Efficiency Potential

Fixture Type	% of Lighting Energy	Savings %	GWh Savings
Incandescent	**5%**	**72%**	**99**
Std Fluorescent / Std Ballast	**58%**	**24%**	**421**
Std Fluorescent / EE Mag Ballast	**13%**	**14%**	**53**
T8 / Electronic Ballast	14%	0%	0
Mercury Vapor	**2%**	**35%**	**21**
Metal Halide	4%	0%	0
High Pressure Sodium	2%	0%	0
Low Pressure Sodium	0.1%	0%	0
Skylights	2%	0%	0
Other	0.1%	0%	0
Total	**100%**	**20%**	**594**

Total Lighting Energy = 2,997 GWh

Figure 4-2
Lighting Energy-Efficiency Potential by Industry



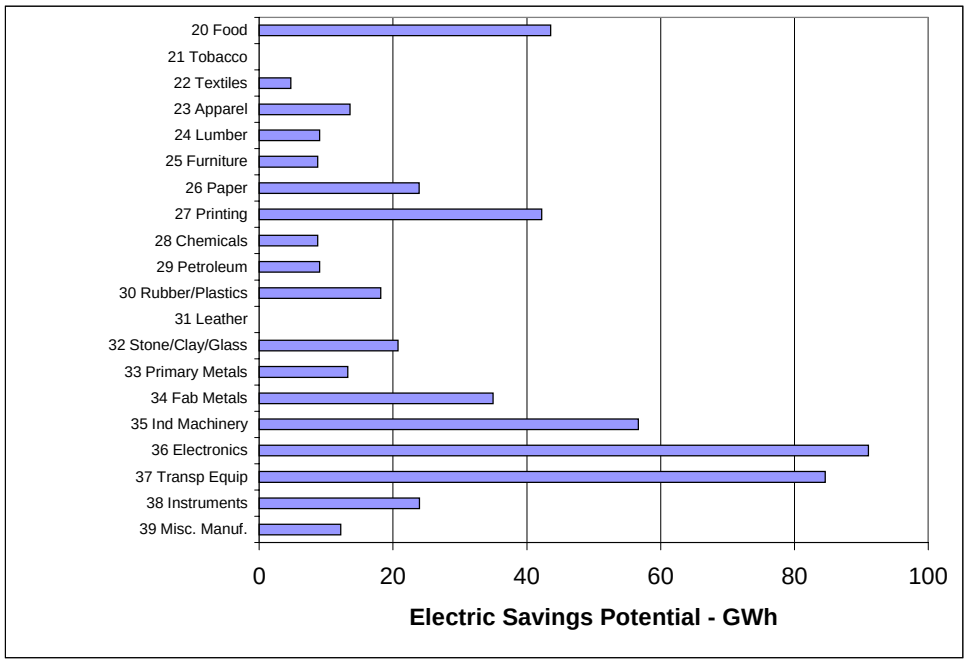
4.3 HVAC

MECS and utility billing data were used to develop HVAC end-use consumption by industry category. SCE 1997 Industrial survey data were then used to identify the portion of HVAC load that was attributable to space cooling. A cooling savings fraction of 24%, developed from commercial energy-efficiency potential data, was then applied to the space cooling load to provide a first-cut estimate of HVAC savings potential. Results are summarized in Table 4-10, and industry-specific savings potential estimates are shown in Figure 4-3. The industries associated with the highest savings potential include Food (SIC 20), Printing (SIC 27), and the high-tech industries (SICs 35, 36, and 37). These five industrial groups account for over 60% of the savings potential for space cooling.

Table 4-10
Space Cooling Energy-Efficiency Potential Calculation

Component	Value	Source
1 HVAC electric use	3,754 GWh	Utility billing data and MECS
2 Cooling fraction	58%	SCE 1997 Industrial Survey
3 Cooling electric use	2,161 GWh	(1) × (2)
4 Cooling savings percent	24%	Average for commercial
5 Cooling savings potential	519 GWh	(3) × (4)

Figure 4-3
Space Cooling Energy-Efficiency Potential by Industry



4.4 STEAM SYSTEMS

The Alliance to Save Energy estimates cost-effective energy-efficiency potential for steam systems to be in the 30-40% range (Table 4-11). This potential focuses on improved energy usage efficiency and excludes possible effects of cogeneration. Measures can be grouped into three main areas: steam generation, system operation and maintenance, and distribution system improvements.

Table 4-11
Steam System Energy-Efficiency Measures

Measures	Savings Potential
Boilers	**2-5%**
Boiler tune-ups	1-2%
Heat recovery equipment	2-4%
Emissions monitoring and control	1-2%
System Operation and Maintenance	**10-15%**
Water control	10-12%
Load control	3-5%
Distribution System	**15-20%**
Steam leaks and traps	3-5%
Condensate return	10-15%
Insulation	5-10%
Total	**30-40%**

Source: DOE-Alliance, 2000

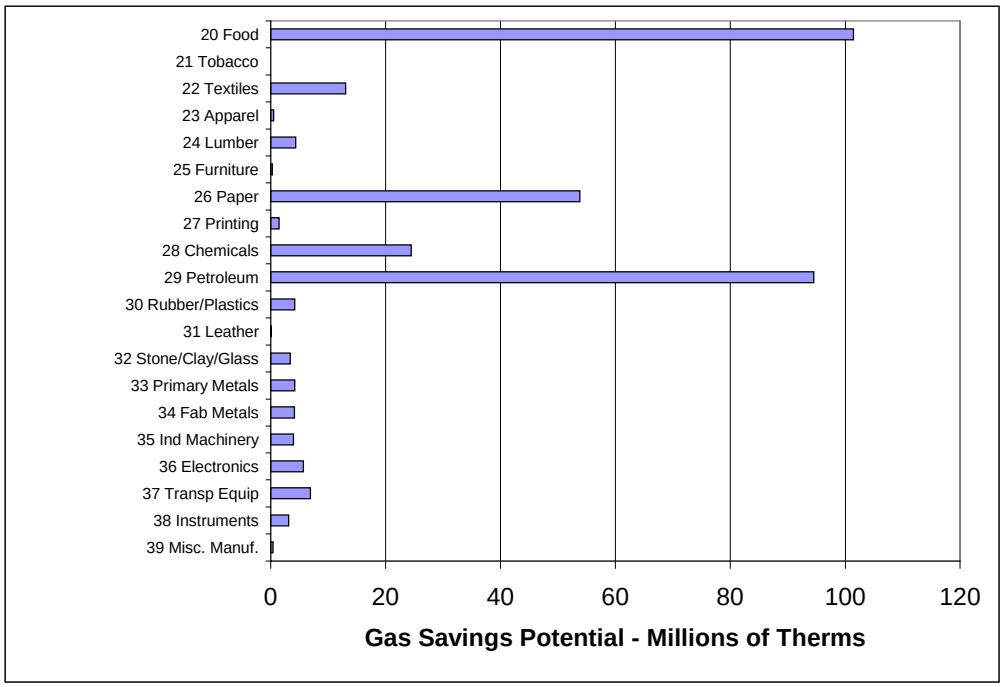
Boiler efficiency is the percentage of the fuel's energy that is converted to steam energy. Efficiency is greatly affected by stack losses, caused by waste heat going "up the chimney." Gas boiler efficiencies range between 76% and 81% for boilers in good repair, and these efficiencies can be increased by 2% to 5%, on average, by reducing stack losses with boiler tune-ups and the installation of auxiliary equipment. Key strategies for minimizing stack losses include: minimizing excess air combustion, keeping boiler heat transfer surfaces clean, and adding flue gas heat recovery equipment where justified. As a rule of thumb, if a boiler has not been maintained for 2 years, a 20-30% gain of efficiency is immediately possible through maintenance (DOE-Alliance, 2000). In addition emissions monitoring and control equipment help reduce excess air in the combustion process.

Important operations and maintenance measures include water treatment and control and load control. Proper water treatment can prevent scaling on boiler tubes and promote efficient heat transfer. Recovering hot condensate for reuse as boiler feed water is another important way to improve efficiency of the system. Replacement of older pneumatic and analog electronic control systems with digital, computer-based distributed control systems can save energy and extend boiler life. Modern, multiple burner control, coupled with air trim control can result in fuel savings of 3% to 5%. For example, a boiler economic load allocation system optimizes the loading of multiple boilers, providing steam to a common header so as to obtain the lowest cost per unit of steam.

Important steam distribution system measures include repair of leaks, maintenance of steam traps, and upgrading and maintaining insulation of steam lines. These measures are typically low-cost or no-cost measures and can provide substantial savings. In addition, reuse of hot condensate in the boiler saves energy and reduces the need for treated boiler feedwater. However, this measure has already been implemented in most of the places where it is easily accomplished.

For purposes of estimating energy-efficiency potential in California, a conservative savings potential of 20% was utilized in this study. This 20% figure is consistent with Steam Challenge efficiency improvement targeted by the year 2010 and LBNL estimates of cost-effective energy-efficiency potential for steam systems. Figure 4-4 shows steam system energy-efficiency potential estimates by industrial category that were developed by applying the 20% savings fraction to estimates of natural gas used for indirect boiler fuel.

Figure 4-4
Steam System Energy-Efficiency Potential by Industry



4.5 PROCESS HEATING

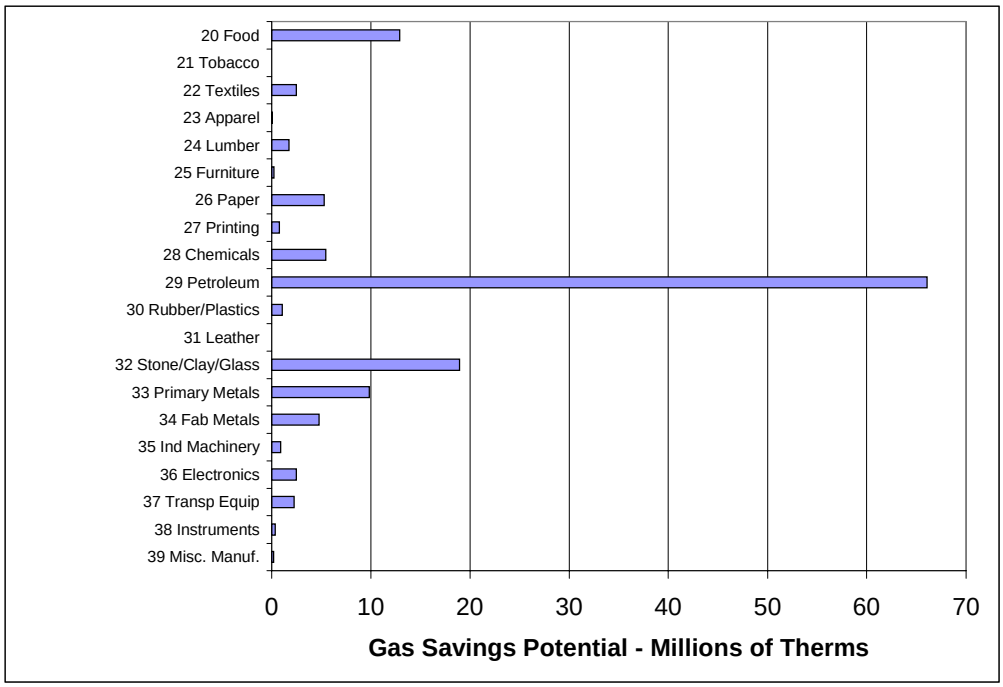
Important process heating energy-efficiency measures are shown in Table 4-12, along with ranges of saving potential estimates. As with steam savings potential, these measures focus on energy usage savings, and potential energy savings from cogeneration projects are excluded. Improved insulation for furnaces, ovens, kilns, and other process heating equipment is estimated to provide the largest potential cost-effective savings under current technologies. Introduction of improved combustion controls and sensors will increase system performance, thereby saving energy. Reduction of excess oxygen will reduce the amount of fuel wasted in heating air that is exhausted through the stack. Heat from flue gasses can be used for a number of applications, including preheating combustion air, producing steam, or preheating boiler feedwater.

Table 4-12
Process Heating Energy-Efficiency Measures

Measures	Savings Potential
Improved Refractory (Insulation)	5-10%
Combustion Controls/Sensors	3-5%
Reduction of Excess O_2	2-3%
Waste Heat Recovery	1-3%
Total	**10-15%**

Industrial savings potential estimates for California were developed assuming a conservative savings potential fraction of 8%. Results are presented in Figure 4-5.

Figure 4-5
Process Heating Energy-Efficiency Potential by Industry



4.6 SUMMARY OF INDUSTRIAL ENERGY-EFFICIENCY POTENTIAL

Industrial energy-efficiency savings potential is summarized in Table 4-13. For electricity, measures addressing machine drive systems show the largest source of potential, accounting for about 11% of the process end use and about 8% of total manufacturing electricity use. Savings potential in the 20% to 25% range for lighting and space cooling offer the next largest sources of electric savings. Natural gas savings potential for manufacturing of about 12% is concentrated in the boiler and process heating end uses.

Table 4-13
Summary of Industrial Energy-Efficiency Potential by Key End Use

Electricity	**GWh**	**% of End Use**	**% of Mfg Use**
Machine Drive (Process)	2,463	11%	8%
Lighting	594	20%	2%
Space Cooling	519	24%	2%
Total Electric	3,576		12%
Natural Gas	**Mth**	**% of End Use**	**% of Mfg Use**
Boilers	330	20%	8%
Process Heat	136	8%	3%
Total Gas	466		12%

Table 4-14 summarizes industrial energy-efficiency potential by industrial category. Key industries for electric savings include Food (SIC 20), Chemicals (SIC 28), Petroleum (SIC 29),

Stone, Clay, and Glass (SIC 32), and the high-tech industries (SICs 35-37). Natural gas energy-efficiency potential is concentrated in Food (SIC 20), Paper (SIC 26), and Petroleum (SIC 29).

Table 4-14
Summary of Energy-Efficiency Potential by End Use and Industry

	Electric Potential - GWh				Gas Potential - Mth		
Industry Category	Motors	Lighting	Space Cooling	Total Electric	Boilers	Process Heat	Total Gas
20 Food	320	54	44	418	101	13	114
21 Tobacco	-	-	-	-	-	-	-
22 Textiles	28	6	5	39	13	2	16
23 Apparel	14	8	14	36	-	-	0
24 Lumber	84	12	9	105	4	2	6
25 Furniture	21	9	9	39	0	0	1
26 Paper	148	21	24	193	54	5	59
27 Printing	74	23	42	139	1	1	2
28 Chemicals	222	24	9	254	24	5	30
29 Petroleum	338	11	9	358	95	66	161
30 Rubber/Plactics	175	29	18	222	4	1	5
31 Leather	1	-	-	1	-	-	-
32 Stone/Clay/Glass	312	38	21	370	3	19	22
33 Primary Metals	112	21	13	146	4	10	14
34 Fab Metals	122	35	35	191	4	5	9
35 Ind Machinery	154	85	57	296	4	1	5
36 Electronics	160	88	91	339	6	3	8
37 Transp Equip	88	67	85	240	7	2	9
38 Instruments	75	54	24	153	3	-	3
39 Misc. Manuf.	15	9	12	37	-	-	-
All Industry Groups	**2,463**	**594**	**519**	**3,576**	**329**	**135**	**464**

Tables 4-15 through 4-18 show energy-efficiency potential estimates by utility. Similar to the statewide numbers, potential estimates were developed by applying estimated savings potential fractions to estimates of end-use consumption (which were developed by applying MECS end use splits to each utility's billing data).

For PG&E (Table 4-15), key sources of electric energy savings include motor systems in the Food (SIC 20), Petroleum (SIC 29), and Stone, Clay, and Glass (SIC 32) industries, and motors, lighting, and HVAC end uses in the Industrial Machinery (SIC 35) and Electronics (SIC 36) industries. The five industry groups each have savings potential of over 140 GWh and together account for over 60% of the PG&E electric savings potential. Primary sources of natural gas savings are steam systems in the Food (SIC 20) industry and both steam and process heating systems in the Petroleum (SIC 29) industry. These two industries account for about 70% of the PG&E gas savings potential.

For SCE (Table 4-16), the largest savings potential is found in motor systems in the Food (SIC 20), Chemicals (SIC 28), Petroleum (SIC 29), Rubber and Plastics (SIC 30), and Stone, Clay, and Glass (SIC 32) industries and motors, lighting, and HVAC end uses in the Electronics (SIC 36) and Transportation Equipment (SIC 37) industries. These seven industry groups account for over 60% of the SCE savings potential.

Table 4-15
Energy-Efficiency Potential Estimates – PG&E

Industry Category	Savings - GWh				Savings - MTh		
	Motors	Lighting	HVAC	Elec Tot	Boilers	Proc Ht	Gas Tot
20 Food	204.4	33.8	27.1	265.3	68.0	6.7	74.7
21 Tobacco	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22 Textiles	4.2	0.9	0.7	5.8	0.2	0.0	0.2
23 Apparel	1.8	1.1	1.8	4.7	0.1	0.0	0.1
24 Lumber	71.6	9.6	7.1	88.3	4.1	1.7	5.8
25 Furniture	2.4	1.2	1.1	4.7	0.0	0.0	0.0
26 Paper	61.9	6.7	7.4	76.0	13.8	1.5	15.3
27 Printing	28.5	9.0	16.3	53.7	0.5	0.3	0.8
28 Chemicals	66.8	8.1	2.9	77.9	10.5	2.7	13.2
29 Petroleum	167.4	5.5	4.9	177.8	51.5	35.7	87.2
30 Rubber/Plastics	46.9	7.6	4.8	59.3	1.6	0.4	2.0
31 Leather	0.6	0.0	0.0	0.6	0.0	0.0	0.0
32 Stone/Clay/Glass	119.9	18.5	9.5	147.9	2.5	12.4	15.0
33 Primary Metals	34.7	6.7	4.2	45.6	0.7	1.9	2.6
34 Fab Metals	33.8	9.6	9.7	53.1	1.0	1.2	2.2
35 Ind Machinery	91.3	57.6	40.4	189.2	2.8	0.3	3.0
36 Electronics	71.1	38.8	40.4	150.3	2.7	1.2	3.9
37 Transp Equip	20.1	9.0	14.0	43.1	1.6	0.8	2.5
38 Instruments	30.5	22.1	9.6	62.2	1.2	0.1	1.4
39 Misc. Manuf.	2.2	1.3	1.7	5.2	0.1	0.0	0.1
Total	1,060.1	247.0	203.8	1,510.8	163.1	66.9	229.9

Table 4-16
Energy-Efficiency Potential Estimates – SCE

Industry Category	Savings - GWh			
	Motors	Lighting	HVAC	Elec Tot
20 Food	111.4	19.1	15.8	146.3
21 Tobacco	0.0	0.0	0.0	0.0
22 Textiles	23.8	4.9	4.0	32.7
23 Apparel	11.5	6.9	11.1	29.5
24 Lumber	11.5	2.4	1.8	15.7
25 Furniture	18.0	7.7	7.3	33.1
26 Paper	85.3	14.6	16.3	116.2
27 Printing	38.5	12.1	22.0	72.6
28 Chemicals	143.7	12.9	4.8	161.4
29 Petroleum	169.8	5.5	3.9	179.1
30 Rubber/Plastics	123.9	20.4	12.9	157.1
31 Leather	0.6	0.0	0.0	0.6
32 Stone/Clay/Glass	189.6	18.4	10.8	218.9
33 Primary Metals	76.0	14.3	8.9	99.1
34 Fab Metals	82.5	23.4	23.7	129.6
35 Ind Machinery	49.7	21.7	12.6	84.0
36 Electronics	71.9	39.3	40.9	152.1
37 Transp Equip	59.6	49.8	60.7	170.1
38 Instruments	34.4	25.1	11.3	70.8
39 Misc. Manuf.	10.0	6.0	7.9	23.9
Total	1,311.7	304.5	276.5	1,892.7

For SDG&E (Table 4-17), both gas and electric savings potential are concentrated in the Chemicals (SIC 28) and high-tech (SICs 35 through 38) industries. These five industries account for about 70% of the electric savings potential and over 80% of the natural gas savings potential.

Table 4-17
Energy-Efficiency Potential Estimates – SDG&E

	Savings - GWh				Savings - MTh		
Industry Category	Motors	Lighting	HVAC	Elec Tot	Boilers	Proc Ht	Gas Tot
20 Food	4.6	0.8	0.7	6.1	0.7	0.2	0.9
21 Tobacco	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22 Textiles	0.2	0.0	0.0	0.3	0.0	0.0	0.0
23 Apparel	0.7	0.4	0.6	1.7	0.0	0.0	0.0
24 Lumber	0.8	0.2	0.1	1.1	0.0	0.0	0.0
25 Furniture	0.7	0.3	0.3	1.2	0.0	0.0	0.0
26 Paper	0.9	0.2	0.2	1.2	0.0	0.0	0.0
27 Printing	6.8	2.2	3.9	12.9	0.0	0.0	0.1
28 Chemicals	11.0	2.8	1.0	14.7	4.3	0.4	4.7
29 Petroleum	0.4	0.0	0.2	0.7	0.2	0.3	0.5
30 Rubber/Plastics	4.5	0.8	0.5	5.8	0.1	0.0	0.2
31 Leather	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32 Stone/Clay/Glass	2.5	0.7	0.4	3.6	0.0	0.2	0.2
33 Primary Metals	1.0	0.3	0.2	1.4	0.0	0.0	0.1
34 Fab Metals	5.4	1.5	1.5	8.5	0.1	0.1	0.2
35 Ind Machinery	12.8	6.0	3.6	22.4	0.6	0.3	0.9
36 Electronics	17.2	9.4	9.8	36.3	1.4	0.6	2.1
37 Transp Equip	8.6	8.3	9.9	26.8	1.7	0.2	1.9
38 Instruments	9.8	7.1	3.1	20.1	1.1	0.1	1.2
39 Misc. Manuf.	3.3	2.0	2.6	7.8	0.0	0.0	0.1
Total	91.2	42.8	38.7	172.7	10.3	2.6	13.0

SCG savings potential (Table 4-18) is concentrated in steam systems in the Food (SIC 20), Paper (SIC 26), and Petroleum (SIC 29) industries, and in process heating systems in the Petroleum industry. These three industry groups account for about 70% of the SCG savings Potential.

Table 4-18
Energy-Efficiency Potential Estimates – SCG

	Savings - MTh		
Industry Category	Boilers	Proc Ht	Gas Tot
20 Food	32.7	6.1	38.7
21 Tobacco	0.0	0.0	0.0
22 Textiles	12.9	2.5	15.3
23 Apparel	0.4	0.1	0.5
24 Lumber	0.2	0.1	0.3
25 Furniture	0.3	0.2	0.5
26 Paper	40.0	3.8	43.8
27 Printing	0.9	0.5	1.4
28 Chemicals	9.7	2.3	12.0
29 Petroleum	42.8	30.1	72.9
30 Rubber/Plastics	2.4	0.6	3.1
31 Leather	0.0	0.0	0.0
32 Stone/Clay/Glass	0.8	6.4	7.2
33 Primary Metals	3.5	7.9	11.4
34 Fab Metals	3.0	3.5	6.6
35 Ind Machinery	0.6	0.3	0.9
36 Electronics	1.6	0.7	2.3
37 Transp Equip	3.6	1.2	4.8
38 Instruments	0.8	0.1	0.9
39 Misc. Manuf.	0.3	0.1	0.4
Total	156.3	66.6	222.9

4.7 ENERGY-EFFICIENCY FEEDBACK FROM INDUSTRIAL CUSTOMERS

Over the past few years, the California utilities have conducted research studies to better understand customer decision-making and the market for industrial energy-efficiency products and services. Important studies include:

- SPC (Standard Performance Contracting) Program evaluations;
- The Large Customer Needs and Wants Study; and
- The PG&E Compressed Air Market Transformation Quantitative Baseline Research Study.

Next, we discuss key findings from these studies as they relate to energy-efficiency in the industrial market.

4.7.1 SPC Program Evaluations

As part of the 1998 and 1999 SPC Program evaluations, baseline studies were conducted to assess the market for energy-efficiency products and services. Several hundred customer interviews were conducted to obtain information on topics relating to a variety of establishment and energy-efficiency characteristics, behaviors, and attitudes.

An important element of the interviews was to gain a better understanding of barriers to energy-efficiency uptake in the nonresidential sector. Some key barriers identified were:

- **Costs.** "Other priorities for capital spending" and "No funds available for investment" were two of the most cited reasons for customers not implementing energy-efficiency ideas.
- **Project uncertainty.** This includes uncertainty of project savings, uncertainty of equipment performance, and uncertainty of firms providing energy-efficiency products and services.
- **Time to get informed about energy-efficiency opportunities.** Information requirements include types of measures, measure performance, costs and savings.
- **Time and cost for selecting contractors.** This includes identifying contractors, providing contractors information on project requirements, and reviewing bids.

Other key findings from SPC evaluation customer baseline interviews include:

- About 60% of all customers and over 90% of the largest customers have taken recent action to reduce energy use. Actions included installing efficient lights, motors, and HVAC, installing energy management systems, and reengineering industrial processes.
- About 26% of all customers and over 60% of the largest customers had identified energy-efficiency opportunities but had not implemented them.
- Most customers target paybacks of 3 years or less for energy-efficiency projects. Excluding "don't know" respondents, over 65% required payback periods under 3 years, and the majority (80%) of these customers required payback periods of 2 year or less.

- Local utilities received the highest credibility rating for provision of energy-efficiency information. The utilities scored significantly higher that other energy services providers such as engineering firms, contractors, and energy service companies (ESCOs), with a mean rating of 8.4 (on a scale of 0 to 10) versus a mean rating of 6.9 for the next highest-scored provider.

4.7.2 Large Customer Needs and Wants Study

The Large Customer Needs and Wants Study was conducted during the second half of 2000. The goal of the project was to gather information on the needs and wants of large customers within the context of current market trends and strategic objectives in order to help the California IOUs plan new and more effective energy-efficiency programs for large business customers.

A central component of the study was a set of workshops utilizing industry experts and decision makers, used to develop findings on perceived customer needs and program recommendations. Industry groups addressed in the study were: biotechnology, semiconductors, aerospace, fruit and vegetable processing, and hospitals.

Key findings of the study, as they relate to utility industrial energy-efficiency program development, are highlighted next.

1. Utilities are perceived as experts on energy-related issues but fail to understand industry needs. Utilities are faulted for a lack of long-term commitment to their large customers, as exemplified by standard efforts to encourage energy savings (through vehicles such as the Express Efficiency and SPC programs).

2. There is a strong desire from industry to enter into mutually beneficial partnerships with utilities. It is important that partners in the utility/business consortium understand each other's business. Energy-efficiency programs should be industry-specific, and the program message needs to emphasize increased productivity over purely increases in energy-efficiency.

3. Large customers believe that utilities should provide strategic guidance regarding energy-efficiency improvements and other energy-related issues. This guidance should come through executive-level interactions, facilitated by experienced consultants and industry associations and should be supported by solid background research and analysis. Customers need to be informed of the importance and benefits of energy-efficiency at a high level within each company's organization.

4. The utilities should also provide tactical guidance on energy-efficiency opportunities through their account representatives, using expert consultants as necessary to increase their credibility when working with the complexities of particular industries. Educating facility managers in making the business case for energy-saving and load-management activities can be an important element in the delivery of energy-efficiency services.

4.7.3 Compressed Air Market Transformation Research

In 1999, PG&E conducted a qualitative research project to establish baseline knowledge of compressed air system operation and maintenance practices. The research project included 270 telephone surveys targeting PG&E's large industrial customers.

Some key findings include:

- Many customers do not understand technical aspects of their compressed air system. Over 50% of the respondents did not know their system's discharge capacity, and over 40% did not have a clear understanding of the relationship between compressor discharge pressure and the largest pressure requirement for a single piece of equipment. In addition, about 40% of the respondents' systems appeared to have inadequate air storage capacity.
- About two-thirds of the survey respondents had done nothing in the past 3 years to reduce their compressed air system costs, but nearly as many think there are opportunities to economically reduce their system's energy costs. Lack of time and knowledge were cited as key barrier to undertaking system efficiency improvements.
- Most customers perform routine preventative maintenance on their systems, but few reported using "performance analysis testing" as part of the process. "Testing" for compressed air leaks generally involves walking through the plant and listening for air leaks.
- Many respondents (45%) indicated they would be interested in a compressed air performance analysis service. Barriers to such a service include customers' lack of knowledge about what services would be provided and the perceived cost-effectiveness of such a service. Even those who expressed interest in performance testing were not sure how valuable it would be or how much they would be willing to pay for it.

4.8 INDUSTRIAL ENERGY-EFFICIENCY ACTIVITY AT THE NATIONAL LEVEL

The U.S. Department of Energy's Office of Industrial Technologies (OIT) works in partnership with U.S. industry to develop and deliver technologies that increase energy-efficiency, improve environmental performance, and boost productivity. OIT programs cover the continuum from long-term R&D to in-plant assessments and demonstrations. These programs help industry partners collaboratively plan, develop, and adopt cleaner and more energy-efficient technologies and practices. Major OIT programs are highlighted below. To date, it does not appear that California energy efficiency programs have taken advantage of resources available through the OIT programs.

BestPractices

Through the BestPractices program, OIT partners receive in-plant assessments, tools, training, and other resources to help them identify plant-wide opportunities for energy savings and process efficiency. BestPractices focuses on key industrial systems:

- Compressed air;
- Motors;

- Process heating; and
- Steam.

The BestPractices program has consolidated a number of OIT industrial initiatives, including the Steam Challenge and the Motors Challenge, to provide a more comprehensive approach to addressing energy-efficiency concerns of partnering companies. Key components of the program include:

- Plant assessments where BestPractices energy teams visit industrial plants and work with the plant or energy manager to perform a hands-on analysis of the plant's energy use. They follow up with recommendations to make your plant more efficient and suggest technologies to improve operations.
- Training, including system-wide and component-specific training programs to help plant managers and energy managers run their plants more efficiently. The training is offered throughout the year and around the country.
- Tools and publications to address industrial partner's energy management needs, including software tools, databases of manufacturers and energy service providers, and a publications library.

Industries of the Future

The Industries of the Future program provides cost-shared support to collaborative R&D partnerships that address the needs of nine energy-intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest products
- Glass
- Metal casting
- Mining
- Petroleum
- Steel

State Industries of the Future

The States Industries of the Future initiative extends many of the energy and environmental benefits of the national Industries of the Future strategy to the state and regional level. The idea is not to recreate national efforts, but rather to expand these opportunities to a larger number of partners and reach smaller businesses and manufacturers that were not initially involved in the IOF effort. The program brings together industry, academia, and state agencies to address the important issues confronting industry in the state. These public-private coalitions facilitate industry solutions locally and enhance economic development.

Enabling Technologies

The Enabling Technologies program offers cost-shared funding for R&D in three key technology areas common to most energy-intensive industries: Combustion, Sensors & Controls, and Industrial Materials for the Future.

Financial Assistance

OIT also offers financial assistance programs to help inventors and small businesses launch their energy-saving ideas (Inventions and Innovation) and to promote demonstrations of energy-efficient technologies by state-industry partnerships (through the National Industrial Competitiveness through Energy, Environment, and Economics program, or NICE^3).

NICE^3 provides funding to state and industry partnerships (large and small business) for projects that develop and demonstrate advances in energy-efficiency and clean production technologies. Industry applicants must submit project proposals through a state energy, pollution prevention, or business development office. State and industry partnerships are eligible to receive a one-time grant of up to $525,000. The industrial partner may receive a maximum of $500,000 in federal funding. Non-federal cost share must be at least 50% of the total cost of the project.

In total, NICE^3 has sponsored over 100 projects, with more than half going to small businesses. NICE^3 has leveraged $26.3 million in federal funds, with $81.8 million in state and industry funds since 1991.

5 UTILITY PROGRAMS AND RELATED ACTIVITIES

In this section utility industrial program activity is summarized and compared to the energy efficiency potential estimated presented in Section 4. First, program accomplishments for the 1995-1999 period are presented and discussed. Next, PY2001 nonresidential programs are reviewed, with a focus on programs addressing the industrial sector. Then this program activity is compared to energy efficiency potential, and identified gaps between industrial energy efficiency potential and utility programs are discussed.

5.1 PROGRAM ACCOMPLISHMENTS

5.1.1 Aggregate Gross Ex Ante Impacts

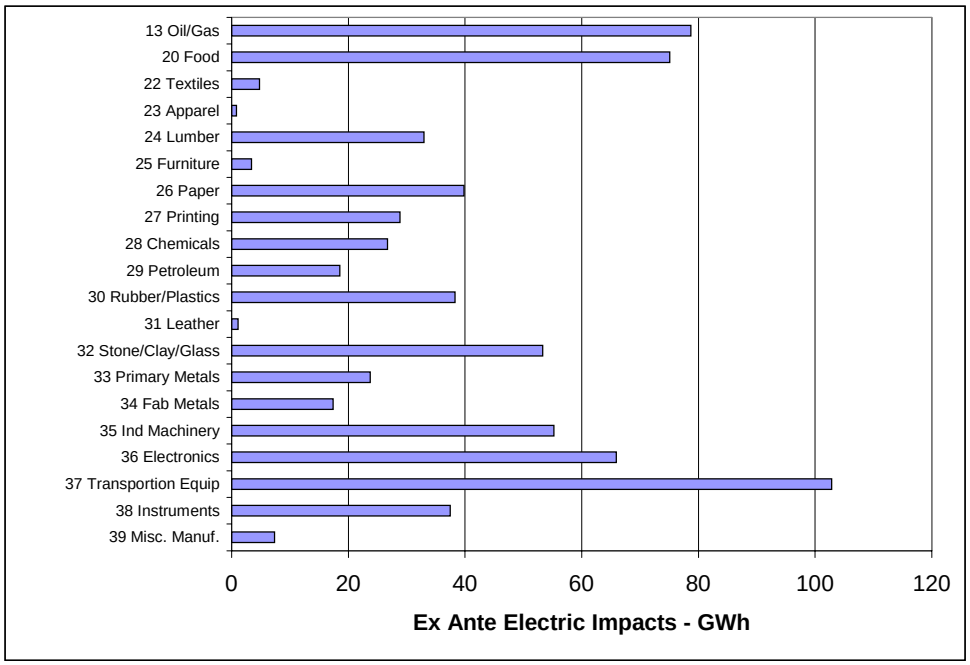
Table 5-1 summarizes utility energy efficiency program accomplishments in the industrial sector for the 1995 through 1999 period in terms of ex ante gross program impacts. The industries contributing most to electric energy impacts include Oil and Gas Extraction (SIC 13), Food (SIC 20), and Transportation Equipment (SIC 37). Chemicals (SIC 28), Transportation Equipment (SIC 37), and Food (SIC 20) contributed most to peak impact accomplishments. Four industries, Oil and Gas Extraction (SIC 13), Food (SIC 20), Petroleum (SIC 29), and Chemicals (SIC 28) accounted for 74% of natural gas impact accomplishments. Accomplishments are shown graphically in Figures 5-1 through 5-3.

Table 5-1
Utility Energy Efficiency Program Accomplishments, 1995-1999

	Ex Ante Gross Impacts			Percent Of Total		
Industry Category	**GWh**	**MW**	**Mth**	**GWh**	**MW**	**Mth**
13 Oil/Gas	78.7	6.7	9.9	11%	5%	29%
20 Food	75.1	10.5	5.0	11%	8%	15%
22 Textiles	4.8	0.4	0.6	1%	0%	2%
23 Apparel	0.8	0.1	0.1	0%	0%	0%
24 Lumber	32.9	2.9	0.5	5%	2%	1%
25 Furniture	3.4	0.8	0.1	0%	1%	0%
26 Paper	39.8	1.6	0.4	6%	1%	1%
27 Printing	28.9	10.3	0.1	4%	8%	0%
28 Chemicals	26.7	44.3	3.4	4%	33%	10%
29 Petroleum	18.5	3.2	7.1	3%	2%	20%
30 Rubber/Plastics	38.3	4.8	0.1	5%	4%	0%
31 Leather	1.1	0.3	0.2	0%	0%	1%
32 Stone/Clay/Glass	53.3	4.4	2.3	7%	3%	7%
33 Primary Metals	23.7	1.9	0.8	3%	1%	2%
34 Fab Metals	17.4	2.5	2.4	2%	2%	7%
35 Ind Machinery	55.2	8.6	0.1	8%	6%	0%
36 Electronics	65.9	9.5	0.5	9%	7%	1%
37 Transportion Equip	102.8	15.0	1.0	14%	11%	3%
38 Instruments	37.5	6.2	0.0	5%	5%	0%
39 Misc Manuf	7.4	0.9	0.0	1%	1%	0%
All Industry Groups	**712.4**	**135.1**	**34.5**	**100%**	**100%**	**100%**

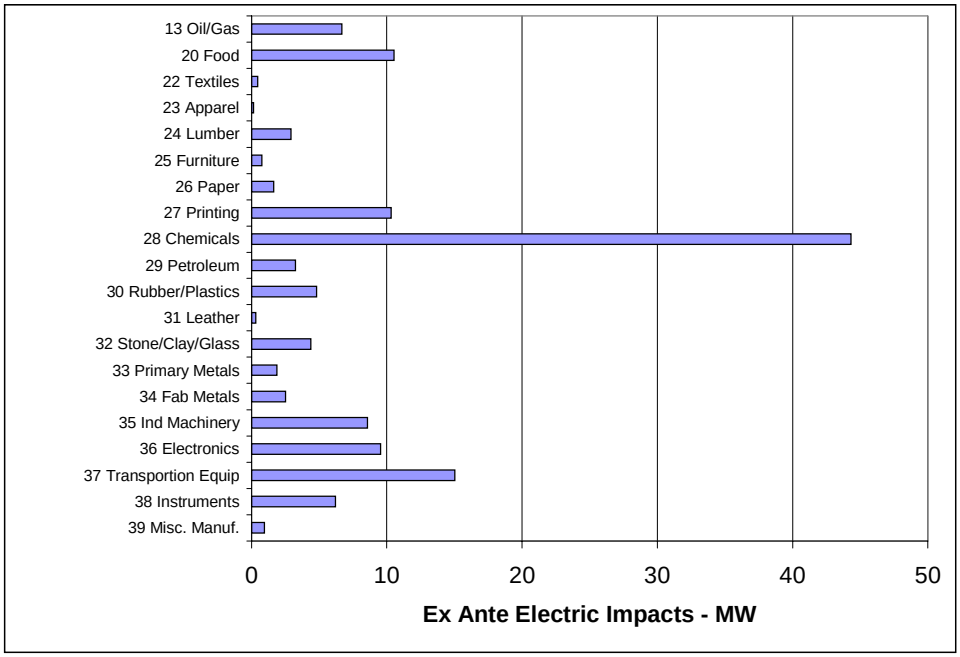
Source: Utility Program Tracking Systems

Figure 5-1
Ex Ante Gross Electric Energy Impacts, 1995-1999



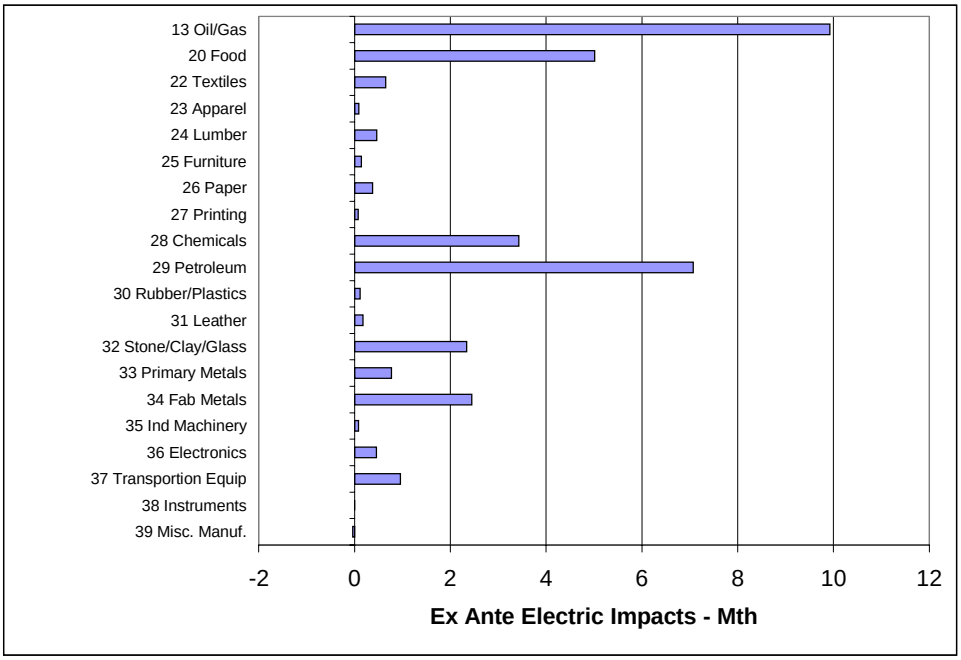
Source: Utility Program Tracking Systems

Figure 5-2
Ex Ante Gross Electric Demand Impacts, 1995-1999



Source: Utility Program Tracking Systems

Figure 5-3
Ex Ante Gross Natural Gas Impacts, 1995-1999

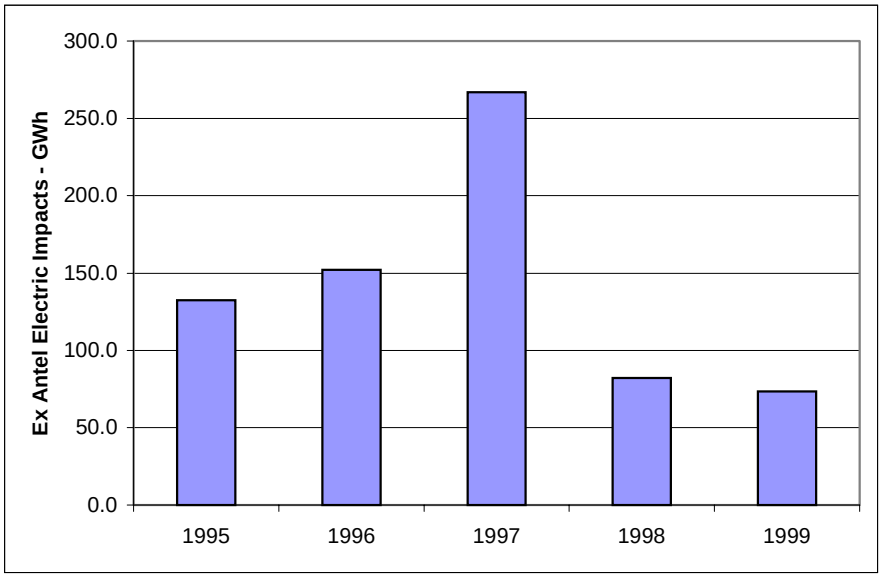


Source: Utility Program Tracking Systems

5.1.2 Gross Ex Ante Impacts by Year

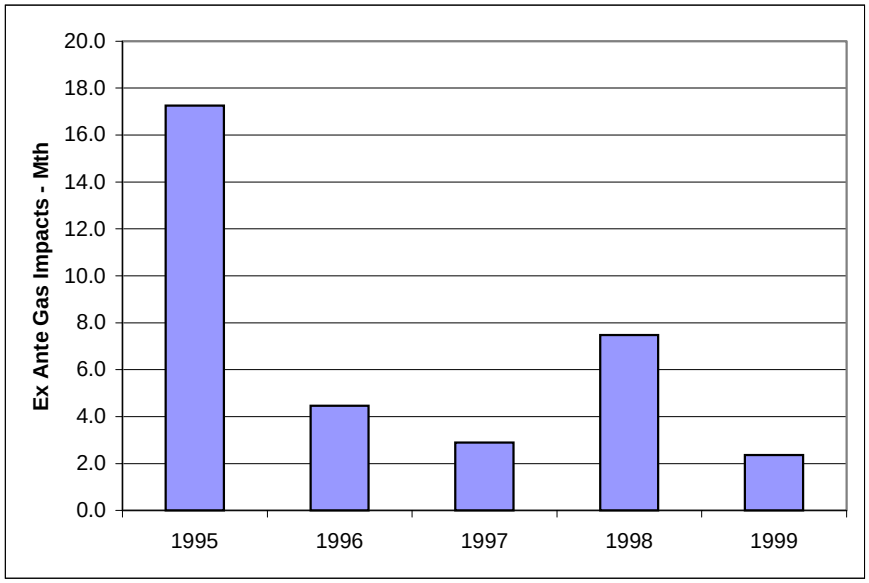
Figures 5-4 and 5-5 show that electric energy program impacts peaked in 1997, while natural gas impacts were highest in 1995. Table 5-2 summarizes impacts by industry and year.

Figure 5-4
Gross Electric Energy Impacts by Year



Source: Utility Program Tracking Systems

Figure 5-5
Gross Natural Gas Impacts by Year



Source: Utility Program Tracking Systems

Table 5-2
Summary of Gross Impacts by Industry and Year

Industry	Impacts - GWh					Impacts - 1000s of Therms				
Category	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999
13 Oil/Gas	16.6	31.1	16.8	6.2	4.3	9,920				
20 Food	18.4	13.3	12.1	16.3	14.7	1,135	1,303	689	445	1,441
22 Textiles	0.1	0.7	2.8	0.4		149		194	195	110
23 Apparel	0.7	0.01	0.1			14		37	38	
24 Lumber	10.6	5.4	13.3	3.4	0.3	339	88	37		
25 Furniture	0.4	0.5	0.5	0.02		0.1		81	9	54
26 Paper	5.5	11.8	19.5	0.3	0.8	313		48		14
27 Printing	3.8	6.7	6.8	3.4	8.0	56	1	7	4	7
28 Chemicals	2.4	4.1	14.2	5.7		86	2,114	1,148	73	7
29 Petroleum	2.2	4.7	1.4	7.8	2.4	1,161	482	99	5,329	
30 Rubber/Plastics	6.3	7.2	11.3	1.2	8.1	15	18	2	55	14
31 Leather	0.9	0.3						65	113	
32 Stone/Clay/Glass	12.9	6.3	5.1	7.4	9.9	1,933	62	7	168	168
33 Primary Metals	3.9	2.8	15.4	0.5	1.2		19	280	273	151
34 Fab Metals	4.1	5.0	4.1	1.3	1.5	1,392	124	165	492	271
35 Ind Machinery	9.9	10.7	15.1	10.2	9.8	15	7	7	22	30
36 Electronics	15.9	8.8	36.1	9.7	0.4	227	34	87	88	20
37 Transp Equip	10.2	18.1	75.5	6.1	4.1	492	215	-4	174	83
38 Instruments	7.7	9.7	15.3	1.5	8.0	7	6	-10	1	
39 Misc Manuf	0.4	4.7	1.7	0.6				-36		
Total	132.6	151.9	267.0	82.1	73.4	17,254	4,473	2,902	7,477	2,372

Source: Utility Program Tracking Systems
Results differ slightly from those in Table 5-1 because a small number of projects where Year was not identified were excluded.

5.1.3 Program Participation

Table 5-3 presents the number of industrial program participants (at the site level) for the 1995-1999 period. The total number of participants was highest in 1997. The largest number of participants comes from Food (SIC 20), Printing (SIC 27), Fabricated Metals (SIC 34), Industrial Machinery (SIC 35), and Electronics (SIC 36).

Table 5-3
Industrial Program Participation by Year

	Participants (Site Level)					
Industry Category	**1995**	**1996**	**1997**	**1998**	**1999**	**Total**
13 Oil/Gas	16	20	18	9	3	66
20 Food	141	89	111	63	20	424
22 Textiles	3	6	17	7	4	37
23 Apparel	4	2	8	3		17
24 Lumber	44	40	34	8	1	127
25 Furniture	10	7	13	3	5	38
26 Paper	26	24	31	5	3	89
27 Printing	64	44	72	23	5	208
28 Chemicals	36	38	41	19	1	135
29 Petroleum	10	8	8	10	1	37
30 Rubber/Plastics	34	50	59	22	7	172
31 Leather	6	2	1	1		10
32 Stone/Clay/Glass	21	22	27	10	11	91
33 Primary Metals	15	15	39	16	9	94
34 Fab Metals	56	51	82	28	20	237
35 Ind Machinery	101	88	114	44	10	357
36 Electronics	83	81	107	49	6	326
37 Transp Equip	31	42	63	10	8	154
38 Instruments	43	45	61	22	12	183
39 Misc Manuf	19	11	26	10		66
All Industry Groups	**763**	**685**	**932**	**362**	**126**	**2,868**

Source: Utility Program Tracking Systems

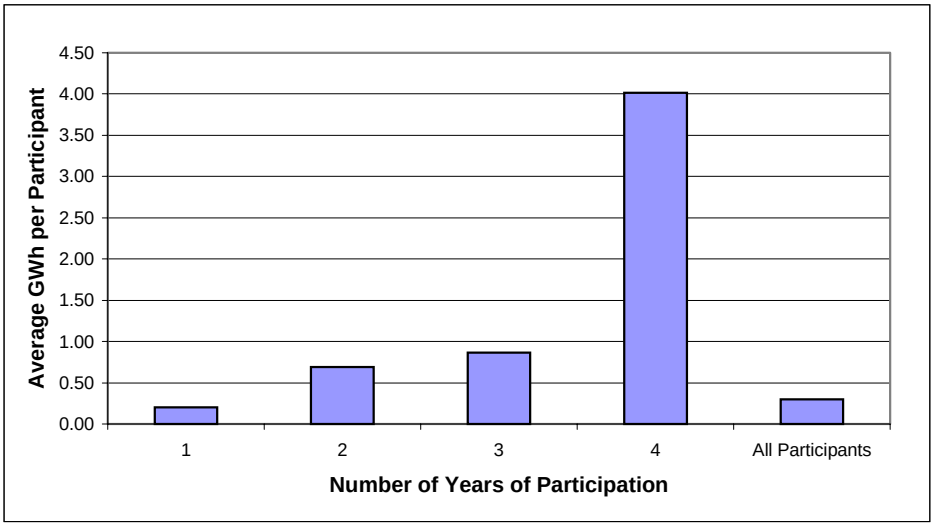
Repeat participation, at the site level, during the 1995-1999 period is addressed in Table 5-4. This table shows that 238 sites participated in two or more program years during the 1995-1999 period, accounting for about 14% of the sites. These repeat participants tended to have larger projects, accounting for 41% of electricity impacts and 30% of natural gas impacts. This observation is reflected graphically in Figures 5-6 and 5-7 which show that average impacts per site tended to be larger for repeat participants.

Table 5-4
Repeat Participation in Utility Energy Efficiency Programs, 1995-1999

		Ex Ante Load Impacts		Shares		
No. Years Participated	**Parti-cipants**	**GWh**	**Mth**	**Parti-cipants**	**GWh**	**Mth**
1	2,049	417.2	24.5	0.86	0.59	0.71
2	260	180.3	9.3	0.11	0.25	0.27
3	63	54.7	0.2	0.03	0.08	0.01
4	15	60.2	0.6	0.01	0.08	0.02
Total (1995-99)	2,387	712.4	34.5	1.00	1.00	1.00

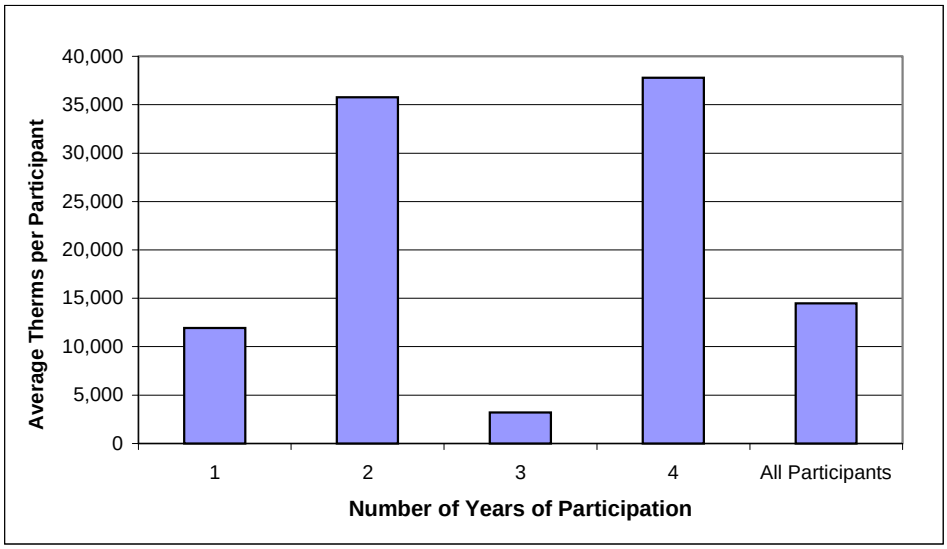
Source: Utility Program Tracking Systems

Figure 5-6
Average Electricity Impacts by Years of Program Participation, 1995-1999



Source: Utility Program Tracking Systems

Figure 5-7
Average Natural Gas Impacts by Years of Program Participation, 1995-1999



Source: Utility Program Tracking Systems

5.1.4 Impacts by End Use

Table 5-5 shows program impacts by end use. The process end use is by far the largest, accounting for over half of the electricity savings and nearly all of the natural gas savings. Key process electricity measures involve compressed air, adjustable speed drives, pumps, and motors.

Primary process natural gas measures involve pumps (in the oil and gas extraction industry), process heating, and boilers. For indoor lighting, HID and T-8 lamp retrofits predominate. Key HVAC measures include efficient chillers, adjustable speed drives, and energy management systems.

Table 5-5
Ex Ante Gross Impacts by Key End Use, 1995-1999

Enduse	GWh	MW	Mth
Process	380.21	78.58	33.24
Lighting-Indoor	169.74	33.56	
HVAC	103.33	14.64	1.01
Refrigeration	40.35	6.06	
Motors	6.99	0.96	
Pumping	3.75	0.40	
Lighting-Outdoor	1.73	0.00	
Cooking	0.00	0.00	0.07
Subtotal	706.11	134.20	34.32

Source: Utility Program Tracking Systems

5.1.5 Impact Summary

Table 5-6 summarizes program impact accomplishments by industry and end use.

Table 5-6
Summary of Gross Ex Ante Program Impacts by End Use and Industry

Industry Category	# Part-icipants	Electricity (GWh)				Natural Gas (Mth)		
		Process	Lighting	HVAC	Total	HVAC	Process	Total
13 Oil/Gas	66	78.5	0.1	0.1	78.7	0.0	9.9	9.9
20 Food	424	55.7	9.1	10.4	75.1	0.003	5.0	5.0
21 Tobacco		0.0	0.0	0.0	0.0	0.0	0.0	0.0
22 Textiles	37	1.4	3.4	0.0	4.8	0.0	0.6	0.6
23 Apparel	17	0.0	0.8	0.0	0.8	0.0	0.1	0.1
24 Lumber	127	26.4	6.5	0.0	32.9	0.0	0.5	0.5
25 Furniture	38	0.3	3.2	0.0	3.4	0.004	0.1	0.1
26 Paper	89	32.7	6.4	0.7	39.8	0.0	0.4	0.4
27 Printing	208	10.4	9.4	9.1	28.9	0.1	0.0	0.1
28 Chemicals	135	21.2	2.2	3.4	26.7	0.1	3.3	3.4
29 Petroleum	37	10.0	2.2	6.3	18.5	0.4	6.6	7.1
30 Rubber/Plastics	172	29.0	6.0	3.3	38.3	0.002	0.1	0.1
31 Leather	10	0.9	0.2	0.0	1.1	0.0	0.2	0.2
32 Stone/Clay/Glass	91	46.2	7.1	0.0	53.3	0.0	2.3	2.3
33 Primary Metals	94	16.6	5.9	1.3	23.7	0.0	0.8	0.8
34 Fab Metals	237	10.1	6.9	0.3	17.4	0.0001	2.4	2.4
35 Ind Machinery	357	18.1	22.8	14.3	55.2	0.01	0.1	0.1
36 Electronics	326	17.1	20.5	28.3	65.9	0.1	0.3	0.5
37 Transportation Equip	154	50.1	39.8	12.9	102.8	0.3	0.7	1.0
38 Instruments	183	7.0	18.4	12.1	37.5	0.005	-0.002	0.003
39 Misc. Manuf.	66	6.0	0.9	0.5	7.4	0.0	-0.04	-0.04
All Industry Groups	**2,868**	**437.7**	**171.5**	**103.2**	**712.4**	**1.0**	**33.5**	**34.5**

Source: Utility Program Tracking Systems

5.1.6 Net to Gross Ratios

Net to gross ratios (NTGRs) show the fraction of gross program accomplishments (such as the accomplishments presented above) that can be attributed to the programs. The NTGRs are used to factor out the effects of free riders – customers who would have installed energy efficiency measures anyway, even without the program incentives – to provide estimates of net program savings. For the 1995 to 1999 period, program impact evaluations included net to gross analyses that estimated NTGRs for each industrial project included in the evaluation. These NTGRs are summarized below. Each summary NTGR is weighted by program impacts.

Table 5-7 shows industrial NTGR estimates by key end use. High efficiency motors achieved the highest average NTGR while HVAC measures achieved the lowest average NTGR.

Table 5-7
Industrial Net to Gross Ratios by End Use, 1995-1999

End Use	Net-to-Gross Ratio	Number of Observations
HVAC	0.67	310
Lighting	0.72	1,152
Miscellaneous	0.72	10
Motors	0.84	190
Process	0.70	425

Source: Utility Program Impact Evaluations
Net-to-gross ratios are avoided-cost weighted averages of project-level ratios.

NTGRs were also summarized by industrial category. Results are presented in Table 5-8. While many industrial categories have a fairly large number of observations upon which the average NTGRs are based on, it is still possible that NTGRs for some of the largest projects will excerpt considerable influence on the averages shown in the table.

To provide some context for the industrial NTGRs, Table 5-9 shows average NTGRs by sector for the 1995 to 1999 period. While some variation in NTGRs will be due to the type of program that was analyzed and the type of net to gross analysis conducted, it is generally accepted that industrial sector NTGRs tend to be lower than those of other sectors. One of the explanations often given for this results is that industrial customers are larger and more sophisticated, and therefore more likely to take advantage of cost effective energy efficiency measures, even without availability of utility programs. Note that recent research indicates that the net-to-gross method used to evaluation industrial projects, the self report method, may be biased downwards relative to other statistical net-to-gross methods used more frequently in residential and commercial studies (Ridge and Associates, October 2001).

Table 5-8
Net to Gross Ratios by Industry, 1995-1999

Industry Category	Net-to-Gross Ratio	Number of Observations
13 Oil/Gas	0.68	53
20 Food	0.63	228
21 Tobacco	-	-
22 Textiles	0.54	14
23 Apparel	1.00	8
24 Lumber	0.41	83
25 Furniture	0.66	18
26 Paper	0.90	88
27 Printing	0.54	169
28 Chemicals	0.71	89
29 Petroleum	0.85	52
30 Rubber/Plastics	0.62	120
31 Leather	0.99	6
32 Stone/Clay/Glass	0.63	73
33 Primary Metals	0.65	69
34 Fab Metals	0.70	119
35 Ind Machinery	0.72	263
36 Electronics	0.76	264
37 Transportation Equip	0.69	147
38 Instruments	0.77	125
39 Misc. Manuf.	0.81	31

Source: Utility Program Impact Evaluations
Net-to-gross ratios are avoided-cost weighted averages of project-level ratios.

Table 5-9
Net to Gross Ratios by Sector, 1995-1999

Sector	Net-to-Gross Ratio
Residential	0.81
Commercial	0.89
Agricultural	0.78
Industrial	0.69

Source: Utility Program Impact Evaluations

5.2 PROGRAM YEAR 2001 ACTIVITY

Nonresidential energy efficiency program information was developed through a review of utility filings, PY2001 1st Quarterly Reports, and program manager interviews. Following is a brief listing of identified programs. A more complete summary of PY2001 program activity is contained in Appendix B.

5.2.1 Common Programs

Nonresidential programs common to all utilities include the following (approximate budgets are provided in parentheses):

- Standard Performance Contract – SPC – ($25 million) provides financial incentives for installation of energy efficient equipment;
- Express Efficiency ($41 million) provides standardized rebates for installation of specific energy efficiency measures and is targeted to small and medium sized customers;
- Energy Audit Programs (2% to 6% of nonresidential program budgets) provide customers with site-specific energy efficiency information, mostly targeted to commercial customers;
- Upstream HVAC Programs ($3.3 million) offer financial incentives to HVAC market actors to encourage the installation of efficiency HVAC equipment;
- Upstream Motor Programs ($1.5 million) offer incentives to motor distributors to encourage premium efficiency motor stocking and sales; and
- Process Overhaul Programs ($5.4 million, mostly SCG programs) are designed to promote energy-efficient process overhauls by providing specialized, technical consulting services to study opportunities related to customer process loads.

As noted, most of the programs and associated funding involves payment of incentives to promote installation of energy efficient equipment. Important exceptions are the Audit and Process Overhaul programs.

5.2.2 Information, Outreach, and Technical Support

The utilities also provide various types of energy efficiency support activities such as:

- Business Energy Guides – designed to help small nonresidential customers better manage their energy costs through energy efficiency;
- Energy Centers – designed to educate customers about energy efficient business solutions;
- Emerging Technologies activities that focus on demonstrating energy efficiency options not widely adopted by various market actors; and
- Renovation and Remodeling programs that encourage high performance nonresidential building design and construction practices.

Much of these support activities target the commercial sector. However, the Emerging Technologies and Renovation and Remodeling areas also support energy efficient related to the industrial sector.

5.2.3 Other Support and Programs

Each of the utilities also offers a number of programs that are designed to support the financial incentives programs (e.g., Express Efficiency, SPC). These programs include such activities as providing special services to upstream market actors such as technical assistance and incentives, targeting more complex applications such as chillers or compressed air systems, and/or providing marketing and outreach support to target market segments such as the hard-to-reach segment. The commercial sector is the primary focus for most of these programs.

The utilities also offer a number of Third Party Initiative and Summer Initiative programs. For the most part, these programs also target the commercial sector.

5.3 ENERGY EFFICIENCY POTENTIAL VERSUS PROGRAMS

In order to understand how industrial energy efficiency programs in California stack up against the energy efficiency potential presented in Section 4 of this report, we look at both impact estimates and the design of the programs.

5.3.1 Impact Accomplishments Compared to Potential

Table 5-10 presents a comparison of program impact accomplishments with identified energy efficiency potential. The comparison is expressed as the ratio of program impacts (from Table 5-6) to identified energy efficiency potential (from Table 4-14). Results show that past rebate programs have been more effective at targeting electricity-saving measures than gas-saving measures. Clearly, electricity savings have been a focus of the rebate programs in California. The ratio of electric tracking savings to identified potential is about 0.18 whereas the ratio of gas savings to gas potential is only 0.05 (both excluding the oil and gas extraction industry). For electricity, lighting measures have had the biggest penetration; the ratio of impacts to potential is about 0.29. In general, program accomplishments have been relatively well dispersed across the different industrial groups.

(Note, the impact-to-potential ratios don't exactly correspond to the fraction of savings potential captured by the rebate programs because of definitional issues. Utility program activity and related impacts are more heavily weighted to equipment-related savings as these programs have typically steered away from promoting maintenance-related measures. On the other hand, the potential analysis focuses more on implementation of lower-cost maintenance and control measures as an important source of energy savings. Despite these differences, the ratios do help provide a good indication of whether program activity has been targeting the key energy consuming end uses.)

5.3.2 Program Approach

While the utility programs have done reasonably well in targeting the appropriate end uses for industrial energy efficiency, they have focused mainly on the purchase and installation of new equipment. Key measures have included lighting fixtures, high efficiency chillers and air conditioners, premium efficiency motors, ASDs, new and more efficient boilers, and new air compressors. A large portion of the PY2001 budget is targeted for the SPC and Express Efficiency programs, which are designed to provide financial incentives for the installation of energy efficient equipment.

Table 5-10
Ratio: Program Impacts (1995-1999) to Energy Efficiency Potential

	Electricity				Natural
Industry Category	Process	Lighting	HVAC	Total	Gas
20 Food	0.17	0.17	0.24	0.18	0.04
21 Tobacco	-	-	-	-	-
22 Textiles	0.05	0.58	0.01	0.12	0.04
23 Apparel	0.00	0.09	0.00	0.02	0.16
24 Lumber	0.31	0.54	0.00	0.31	0.08
25 Furniture	0.01	0.35	0.00	0.09	0.28
26 Paper	0.22	0.30	0.03	0.21	0.01
27 Printing	0.14	0.40	0.22	0.21	0.03
28 Chemicals	0.10	0.09	0.39	0.11	0.11
29 Petroleum	0.03	0.20	0.70	0.05	0.04
30 Rubber/Plastics	0.17	0.21	0.18	0.17	0.02
31 Leather	-	-	-	-	-
32 Stone/Clay/Glass	0.15	0.19	0.00	0.14	0.10
33 Primary Metals	0.15	0.28	0.10	0.16	0.05
34 Fab Metals	0.08	0.20	0.01	0.09	0.27
35 Ind Machinery	0.12	0.27	0.25	0.19	0.02
36 Electronics	0.11	0.23	0.31	0.19	0.06
37 Transportion Equip	0.57	0.59	0.15	0.43	0.10
38 Instruments	0.09	0.34	0.50	0.24	0.00
39 Misc. Manuf.	0.39	0.10	0.04	0.20	-0.06
Total	**0.15**	**0.29**	**0.20**	**0.18**	**0.05**

Note: SIC 13, Oil/Gas Extraction is excluded because energy efficiency potential estimates were not available.

Important exceptions to the incentive-type programs are the Audit programs that primarily target small and medium sized commercial customers and the Process Overhaul programs that provide technical consulting services to identify process-related energy improvements. These programs, however, receive relatively small budgets.

A review of the literature on energy savings potential reveals that considerable savings can be obtained by making "systems" more efficient, often through the use of improved operation and maintenance practices, improved system design, and the installation of control measures. These types of measures are not easily promoted through traditional incentive programs. In many cases, industrial customers are not aware of the types of measures that can achieve energy savings or the magnitude of savings that can be achieved through the implementation of systems solutions. Programs that seek to inform customers of their energy efficiency potentials, options, and associated benefits/costs and connect them to contractors and financing, providing turn-key projects, are likely to garner significant cost-effective energy savings that are missed by traditional incentive programs.

6 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes conclusions of this study and provides recommendations regarding industrial energy-efficiency program design and future research to support industrial energy-efficiency activities.

6.1 STUDY CONCLUSIONS

The primary study conclusions are summarized below.

Most energy use and savings potential are concentrated in the largest sites. As shown in Section 3 of this report, the 2,400 largest sites with electric demands of 500 kW or more (6% of all industrial sites) account for over 70% of industrial electricity usage. The 1,300 largest sites with natural gas consumption of over 250,000 therms per year (4% of sites) account for over 90% of industrial natural gas usage.

Key energy-efficiency areas include motors, steam, and process-heating systems. On the electric side, machine drive systems account for about 49% of industrial consumption. Application of cost-effective equipment and practices (with 3-year or better paybacks) could save as much as 14% of machine drive energy use or over 2,400 GWh. About three-fourths of this savings potential involves system measures above and beyond the changeout to high-efficiency motors. System measures include: maintenance, matching system component sizes to loads, and reducing load requirements through system design.

On the natural gas side, steam systems account for about 42% of industrial consumption, with cost-effective savings potential of about 20% associated with such measures as: boiler tune-ups, heat recovery, water and load control measures, distribution system insulation, and maintenance of steam leaks and traps. Process heating systems account for about 43 % of industrial gas consumption, with potential savings of about 8% achievable through implementation of such measures as increased insulation, waste heat recovery, reduction of excess air during combustion, and installation of controls and sensors.

Natural gas potential appears relatively untapped. Most of the energy-efficiency program activity in the 1990s was targeted at electric technologies, primarily lighting, HVAC, compressed air, ASDs, motors, and a number of customized measures. While some gas boiler and process heating projects were undertaken, they did not receive the attention that electric measures received.

Many customers appear to be uninformed about the costs and benefits of energy-efficiency projects, especially those related to system improvements. Based on PG&E's compressed air market research, only 10% of surveyed customers track the energy cost of their compressed air system, and only 24% of respondents conduct performance analysis testing. Many respondents

in the study did not appear to be knowledgeable about key aspects of their compressed air systems – over one-half did not know their system's discharge capacity and about 40% had inadequate air storage capacity for their system. Customers surveyed as part of the SPC evaluations indicated that important barriers to energy-efficiency uptake included uncertainty of project savings and the amount of time it takes to get informed about energy-efficiency opportunities.

Energy-efficiency programs have been more equipment focused and not system focused. Utility programs in the 1990s were predominantly rebate programs that provided cash incentives for the installation of efficient equipment. While some customized projects included system enhancements, most rebates were tied to the installation of new, high-efficiency equipment.

Industrial customers look to the utilities for credible energy-efficiency guidance. Both the Large Customer Needs and Wants Study and the SPC evaluation studies indicated that utilities were considered the most reliable source of energy-efficiency information. Customers indicated a strong desire to enter into mutually beneficial relationships with their utility suppliers.

6.2 PROGRAM DESIGN RECOMMENDATIONS

The current array of utility programs that rely predominantly on customer incentives will continue to achieve significant impacts, especially under the current energy environment. However, programs that tend to favor equipment change-outs will continue to miss opportunities to improve the energy efficiency of industrial systems. Programs that focus on customer education and programs that provide expert facility analyses will most likely be more effective at targeting "system" energy efficiency. Further recommendations for program design include the following elements.

Programs should target large customers. Most industrial energy usage and accompanying savings potential is concentrated in a relatively small number of large facilities. Focusing program resources on these facilities will most likely provide the largest amount of cost-effective savings.

Programs should focus on energy-using systems. This study has found that considerable cost-effective savings potential is likely from improving machine drive, steam, and process heating system efficiencies. Much of the focus of national energy-efficiency efforts is on improving system efficiency, and savings appear to be achievable without the large capital expenditures required to replace large pieces of equipment.

California programs should try to better leverage the energy-efficiency work of others, such as the U.S. DOE. The DOE Office of Industrial Technology has sponsored a number of research and development efforts to address energy efficiency of industrial systems. The California utilities should investigate ways to incorporate these efforts into the design of future industrial programs.

Programs targeting large customers should utilize the utility account representative network. Large customers have indicated a willingness to partner with the California utilities and have indicated that tactical guidance on energy-efficiency opportunities be provided by account representatives. The utilities continue to get the highest credibility ratings from customers regarding the provision of energy-efficiency services, and programs should take advantage of this credibility.

Utilities should consider developing programs that provide site-specific studies of energy-using systems. Many industrial customers need to better understand the costs and benefits of improving the energy efficiency of the machine drive, steam, and process heating systems before they will consider energy-efficiency investments in these systems. Site studies/audits need to be of high quality to get customer buy-in, and therefore industry experts on various energy-using systems should be utilized to the extent possible. Studies also need to provide cost-effectiveness calculations in addition to energy savings estimates so customers can see the bottom line impacts of proposed investments in energy efficiency.

Utilities should reserve financial incentives for the measures with "marginal" cost effectiveness. If customers are informed of energy savings opportunities with relatively short payback periods (for example, 1 year or less), they are likely to undertake these projects on their own as part of good business practices – especially if the measures involved use established technologies. As project payback periods approach the 3-year threshold and/or project impacts are less certain, customers may require financial incentives to move projects through their financial approval process.

Utilities should assist the customer in implementing energy-efficiency projects. The time it takes to research energy-efficiency projects and to select contractors to implement projects are cited as significant barriers to increased energy efficiency. Since utilities are considered to be credible and unbiased sources of energy-efficiency information, their playing a role in project implementation would likely increase customers' willingness to proceed with projects.

Utilities should provide unbiased measurement and verification (M&V) activities for energy-efficiency projects. Activities could include items such as funding of M&V studies, selection of M&V contractors, provision of M&V equipment, and review of customer M&V studies. Appropriate M&V activities can provide customers with positive feedback for projects that involve system enhancements whose initial savings estimate may be relatively uncertain. M&V studies that also address increase plant productivity would be especially useful at encouraging additional energy-efficiency investments.

6.3 RECOMMENDATIONS FOR FUTURE RESEARCH

The industrial characterization study identified a number of areas for potential future research to better understand industrial energy efficiency opportunities. Recommendations are presented next.

6.3.1 Understanding Important Energy-Consuming Industries

At the 2-digit SIC code level, there are several industries that consume large amounts of electricity and natural gas. A better understanding of these industries may provide insight into large energy-efficiency opportunities.

Oil and Gas Extraction (SIC 13) ranks third among industrial categories in natural gas consumption and ninth among industrial categories in electricity consumption. Natural gas is used to drive pumps and compressors to extract and transport oil and to produce steam for injection into "heavy oil" fields, loosening up the oil to permit pumping to the surface. Electricity is primarily used to drive oil-pumping equipment. While this study did not address energy efficiency opportunities in the oil and gas extraction industry, the large consumption levels and relatively homogeneous operations in this industry make it a potential target for energy efficiency activities.

A study that assesses energy usage fundamentals in this industry (number of pumps, current efficiencies of pumps, current efficiency of steam injection operations, possible efficiency and control measures, customer decision-making issues, etc.) could help determine which energy-efficiency opportunities are worth investigating and promoting.

Food and Kindred Products (SIC 20) ranks first in electricity consumption and second in natural gas consumption. This industry is comprised of a diverse group of sub-industries such as canned fruits and vegetables (SIC 2033), milk production (SIC 2026), wine and brandy production (SIC 2084), and beet sugar refining (SIC 2063). Energy-efficiency potential in the food processing industry appears large, especially in the machine drive end use (electricity) and the process steam end use (natural gas). Some food processing facilities are seasonal, with plenty of down time for plant improvements, and some are nearly continuous (dairy operations), such that capital improvements must be carefully scheduled. Studies targeting sub-industries in the food processing category could help program managers better understand the opportunities and operating constraints faced by customers when they consider implementing energy-efficiency projects.

Petroleum Refining (SIC 29) ranks first in natural gas consumption and eighth in electricity consumption. The industry in California is dominated by a small number of large facilities. Large electricity and natural gas savings potential appears likely in the refining industry, but there are constraints. Plant engineers will normally have targeted a number of "cost-effective" energy-efficiency improvement projects, but funding and scheduling of these projects is given lower priority to essential plant modifications. The refineries are continually adjusting to changing environmental regulations, both in terms of site emissions and composition of petroleum products. In many cases, plant modifications are necessary just to "remain in business." In addition, lack of excess refinery capacity in California causes facilities to operate continuously, and schedule modification and maintenance schedules very carefully. Energy efficiency projects that can be coordinated or combined with essential plant modification projects are much more likely to be implemented.

Because of the complexity of this industry and the large size of the refineries, a study to support energy-efficiency improvements in the refinery industry may want to focus on in-depth interviews of facility engineers and collection of supporting information (such as plans for potential energy-efficiency projects and commissioned third-party reports). Identification of and interviews with key decision makers would also help the utilities understand what it takes to increase the implementation of energy-efficiency projects at the refineries.

6.3.2 Better Understanding Energy-Efficiency Potential in Key End Uses

While this study provided initial energy efficiency potential estimates for the predominant industrial end uses, it relied on national data and broad estimates of savings potential fractions. Further research into selected end uses and applications may provide program managers and planners with considerable insight into how they can develop programs to target these end uses. (For example, PG&E has conducted several studies on compressed air systems, looking at factors such customers' understanding of their compressed air systems and decision-making practices regarding improvement of compressed air energy efficiency.)

Based on initial savings potential estimates and limited research activities to date, it is recommended that the following end uses/applications be considered for future research:

- **Pump systems.** Savings potential for pumping systems was estimated to be over 800 GWh before considering additional savings possible from efficiency improvements to pump motors. Industries with the largest potential pump system savings include Food (SIC 20), Paper (SIC 26), Chemicals (SIC 28), Petroleum (SIC 29), and Stone Clay and Glass (SIC 32). In addition, significant pumping savings appear attainable in the high-tech industries (SICs 35-38).
- **Steam systems.** Steam systems show the largest natural gas savings potential at over 300 Mth per year, based on estimates from this study. Most savings appear to be concentrated in four manufacturing industries, Food (SIC 20), Paper (SIC 26), Chemicals (SIC 28), and Petroleum (SIC 29).
- **Process heating systems.** Natural gas savings of over 100 Mth per year are estimated for process heating systems. Much of the savings potential is concentrated in the petroleum refining industry (SIC 29). Other industries with relatively large savings potential include Food (SIC 20), Stone, Clay, and Glass (SIC 32), and Primary Metals (SIC 33).

Recommended research would involve customer interviews and case studies:

- **Customer interviews** could target a wide range of customers who are likely have key energy-using end uses. Questions could address: whether customers have these systems, their knowledge of energy-efficiency activities related to these systems, energy-efficiency investments they have made in these systems, system maintenance practices, and barriers to energy-efficiency improvements on these systems.

- **Case studies** could be used to firm up energy savings potential estimates in terms of various dimensions such as savings fractions, cost effectiveness of potential improvements, feasibility of implementing energy-efficiency measures, and a more in-depth assessment of barriers to making energy-efficiency improvements.

6.3.3 Understanding the Penetration of High-Efficiency Equipment

While much of the equipment used in industry is specialized and efficiency levels are not readily interpretable, assessment of high-efficiency penetration might be possible for some equipment such as boilers, chillers, motors, pumps, fans, compressors, and certain control equipment. The most cost-effective means of collecting these data appears to be interviews with supply-side firms. Critical success factors for this type of data collection include identification recruitment of key respondents, developing interview guidelines that target the key research issues, and execution of interviews to ensure accurate transfer of information and to maintain high levels of satisfaction from the interviewees.

6.3.4 Assess the Market for Expert Consultants

One program-design recommendation is to increase industrial customers' awareness of energy and cost savings potential through the use of high-end audits of key industrial systems provided by expert consultants. To ensure the feasibility of this type of program, there must be an adequate supply of expert consultants to perform high-end systems audits.

One study recommendation is to develop a directory of such experts, focusing on an array of key end uses/applications such as pumping, compressed air, steam, and process heating. To be useful, this study would involve several steps including: 1) development of an initial list of firms using tools such as literature searches, Internet searches, and word of mouth; and 2) refinement of the list using follow-up interviews to ensure that each firm provides services that would be required of a high-end audit program. Services would need to include: identification of energy-efficiency opportunities through on-site inspection, quantification of potential savings, detailed measure-specific recommendations, cost-effectiveness calculations for measure installations, and effective report writing to promote customer implementation of measures.

6.3.5 Small Industrial Customer Needs and Wants

As part of the Nonresidential Market Assessment project, over 750 small electric customers (under 500 kW) were surveyed during the summer of 2000. This survey included over 100 industrial and TCU (transportation, communications, and utility) customers. Research questions addressed in the study include:

- What aspect of the energy crisis affected <500 kW customers the most?
  - What conservation actions have they taken and why?
- What type of equipment changes have < 500 kW customers made and why?
- What are program awareness and participation levels among < 500 kW customers?

- What are <500 kW customers' barriers to adopting energy efficiency and what do they need/want to make energy-efficient decisions?

While some results may break out findings for industrial customers, the primary focus of the study was on the commercial sector.

Additional analysis of this data, with respect to the industrial sector, may be useful in comparing small commercial and industrial issues and may provide information for the development of programs targeting small industrial customers.

6.3.6 Integration of U.S. Department of Energy Industrial Activities

The U.S. Department of Energy (DOE) sponsors a number of programs designed to promote industrial energy efficiency, primarily though the Office of Industrial Technology. At present, it does not appear that the California utilities have leveraged DOE's efforts to the fullest extent possible.

One research project that may prove useful the utility program managers would be a summary of DOE activities directed towards the industrial sector and development of possible initiatives that would facilitate integration of DOE activities into California's industrial energy-efficiency programs.

6.3.7 Assessment of Industrial Program Activities in Other States

While this current study looked at energy-efficiency practices in other states, the secondary source data that were reviewed did not provide a sufficient picture of what others were doing to promote industrial energy efficiency. Additional research involving telephone interviews of key personnel from utilities, government, academia, and other related organizations may shed some light on program design practices throughout the U.S. This information may be useful to program managers as they look for different way to increase industrial energy-efficiency uptake.

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A SIC CODE TO NAICS CODE MAPPING

The North American Industry Classification System (NAICS) was developed jointly by the U.S., Canada, and Mexico to provide new comparability in statistics about business activity across North America. The NAICS codes are gradually replacing the Standard Industrial Classification (SIC) codes in classifying businesses and industries for statistical purposes. NAICS responds to increasing and serious criticism about the SIC. It reflects the structure of today's economy in the United States, Canada, and Mexico, including the emergence and growth of the service sector and new and advanced technologies.

In this report, SIC code system was utilized because most of the relevant data sources still categorized industries by SIC code. However, in the future increasing reliance will be placed on the NAICS as it becomes the main reporting structure for federal agencies.

Table A-1 presents a mapping of Standard Industrial Classification (SIC) codes to North American Industry Classification System (NAICS) codes.

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Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
13			Oil and gas extraction		
1311			Crude Petroleum and Natural Gas	211111	Crude Petroleum and Natural Gas Extraction
1321			Natural Gas Liquids	211112	Natural Gas Liquid Extraction (pt)
1381			Drilling Oil and Gas Wells	213111	Drilling Oil and Gas Wells
1382			Oil and Gas Field Exploration Services		
1382	pt		. Geophysical Mapping and Surveying	54136	Geophysical Surveying and Mapping Services (pt)
1382	pt		. Other Oil and Gas Field Exploration Services	213112	Support Activities for Oil and Gas Operations (pt)
1389			Oil and Gas Field Services, NEC	213112	Support Activities for Oil and Gas Operations (pt)
20			Food and kindred products		
2011			Meat Packing Plants	311611	Animal (except Poultry) Slaughtering (pt)
2013			Sausages and Other Prepared Meats		
2013	pt		. Lard Made From Purchased Material	311613	Rendering and Meat Byproduct Processing (pt)
2013	pt		. Except Lard Made From Purchased Material	311612	Meat Processed from Carcasses (pt)
2015		@	Poultry Slaughtering and Processing		
2015	pt		. Poultry Processing	311615	Poultry Processing
2015	pt		. Egg Processing	311999	All Other Miscellaneous Food Manufacturing (pt)
2021			Creamery Butter	311512	Creamery Butter Manufacturing
2022			Natural, Processed, and Imitation Cheese	311513	Cheese Manufacturing
2023			Dry, Condensed, and Evaporated Dairy Products	311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing
2024			Ice Cream and Frozen Desserts	31152	Ice Cream and Frozen Dessert Manufacturing
2026			Fluid Milk		
2026	pt		. Ultra-High Temperature	311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing (pt)
2026	pt		. Except Ultra-High Temperature	311511	Fluid Milk Manufacturing
2032			Canned Specialties		
2032	pt		. Canned Specialties	311422	Specialty Canning
2032	pt		. Canned Pudding	311999	All Other Miscellaneous Food Manufacturing (pt)
2033		@	Canned Fruits, Vegetables, Preserves, Jams, and Jellies	311421	Fruit and Vegetable Canning (pt)
2034			Dried and Dehydrated Fruits, Vegetables, and Soup Mixes		
2034	pt		. Dried and Dehydrated Fruits and Vegetables	311423	Dried and Dehydrated Food Manufacturing (pt)
2034	pt		. Soup Mixes Made from Purchased Dried and Dehydrated Vegetables	311999	All Other Miscellaneous Food Manufacturing (pt)
2034	pt		. Vegetable Flours	311211	Flour Milling (pt)
2035			Pickled Fruits and Vegetables, Vegetable Sauces and Seasonings, and Salad Dressings		
2035	pt		. Pickled Fruits and Vegetables	311421	Fruit and Vegetable Canning (pt)
2035	pt		. Sauces and Salad Dressings	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing (pt)
2037			Frozen Fruits, Fruit Juices, and Vegetables	311411	Frozen Fruit, Juice, and Vegetable Manufacturing
2038			Frozen Specialties, NEC	311412	Frozen Specialty Food Manufacturing
2041			Flour and Other Grain Mill Products	311211	Flour Milling (pt)
2043			Cereal Breakfast Foods		
2043	pt		. Coffee Substitute	31192	Coffee and Tea Manufacturing (pt)
2043	pt		. Breakfast Cereal	31123	Breakfast Cereal Manufacturing
2044			Rice Milling	311212	Rice Milling
2045			Prepared Flour Mixes and Doughs	311822	Flour Mixes and Dough Manufacturing from Purchased Flour
2046			Wet Corn Milling		
2046	pt		. Refining Purchased Oil	311225	Fats and Oils Refining and Blending (pt)
2046	pt		. Except Refining Purchased Oil	311221	Wet Corn Milling

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2047			Dog and Cat Food	311111	Dog and Cat Food Manufacturing
2048			Prepared Feed and Feed Ingredients for Animals and Fowls, Except Dogs and Cats		
2048	pt		. Animal Slaughtering for Pet Food	311611	Animal (except Poultry) Slaughtering (pt)
2048	pt		. Except Slaughtering Animals for Pet Food	311119	Other Animal Food Manufacturing (pt)
2051			Bread and Other Bakery Products, Except Cookies and Crackers	311812	Commercial Bakeries (pt)
2052		@	Cookies and Crackers		
2052	pt		. Cookie and Cracker	311821	Cookie and Cracker Manufacturing
2052	pt		. Pretzels, Except Soft	311919	Other Snack Food Manufacturing (pt)
2052	pt		. Unleavened Bread and Soft Pretzels	311812	Commercial Bakeries (pt)
2053			Frozen Bakery Products, Except Bread	311813	Frozen Cakes, Pies, and Other Pastries Manufacturing
2061			Cane Sugar, Except Refining	311311	Sugarcane Mills
2062			Cane Sugar Refining	311312	Cane Sugar Refining
2063			Beet Sugar	311313	Beet Sugar Manufacturing
2064		@	Candy and Other Confectionery Products		
2064	pt		. Chocolate Confectionery	31133	Confectionery Manufacturing from Purchased Chocolate (pt)
2064	pt		. Nonchocolate Confectionery Manufacturing	31134	Nonchocolate Confectionery Manufacturing (pt)
2066			Chocolate and Cocoa Products		
2066	pt		. Chocolate Products Made From Purchased Chocolate	31133	Confectionery Manufacturing from Purchased Chocolate (pt)
2066	pt		. Chocolate and Confectionery Products Made From Cacao Beans	31132	Chocolate and Confectionery Manufacturing from Cacao Beans
2067		@	Chewing Gum	31134	Nonchocolate Confectionery Manufacturing (pt)
2068		@	Salted and Roasted Nuts and Seeds	311911	Roasted Nuts and Peanut Butter Manufacturing (pt)
2074		@	Cottonseed Oil Mills		
2074	pt		. Cottonseed Processing	311223	Other Oilseed Processing (pt)
2074	pt		. Processing Purchased Cottonseed Oil	311225	Fats and Oils Refining and Blending (pt)
2075			Soybean Oil Mills		
2075	pt		. Soybean Processing	311222	Soybean Processing (pt)
2075	pt		. Processing Purchased Soybean Oil	311225	Fats and Oils Refining and Blending (pt)
2076		@	Vegetable Oil Mills, Except Corn, Cottonseed, and Soybeans		
2076	pt		. Vegetable Oilseed Processing, except Corn, Cottonseed, and Soybeans	311223	Other Oilseed Processing (pt)
2076	pt		. Processing Purchased Vegetable Oils, except Corn, Cottonseed, and Soybeans	311225	Fats and Oils Refining and Blending (pt)
2077		@	Animal and Marine Fats and Oils		
2077	pt		. Animal Fats and Oils	311613	Rendering and Meat Byproduct Processing
2077	pt		. Canned Marine Fats and Oils	311711	Seafood Canning (pt)
2077	pt		. Fresh and Frozen Marine Fats and Oils	311712	Fresh and Frozen Seafood Processing (pt)
2079			Shortening, Table Oils, Margarine, and Other Edible Fats and Oils, NEC		
2079	pt		. Processing Fats and Oils from Purchased Fats and Oils	311225	Fats and Oils Refining and Blending (pt)
2079	pt		. Processing Soybean Oil from Soybeans Crushed in the Same Establishment	311222	Soybean Processing (pt)
2079	pt		. Processing Vegetable Oils, except Soybeans, from Oilseeds Crushed in the Same Establishment	311223	Other Oilseed Processing (pt)
2082			Malt Beverages		
2082	pt		. Malt Extract	311942	Spice and Extract Manufacturing (pt)
2082	pt		. Except Malt Extract	31212	Breweries
2083			Malt	311213	Malt Manufacturing
2084			Wines, Brandy, and Brandy Spirits	31213	Wineries (pt)
2085			Distilled and Blended Liquors		

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2085	pt		. Applejack	31213	Wineries (pt)
2085	pt		. Except Applejack	31214	Distilleries
2086			Bottled and Canned Soft Drinks and Carbonated Waters		
2086	pt		. Soft Drinks	312111	Soft Drink Manufacturing
2086	pt		. Bottled Water	312112	Bottled Water Manufacturing (pt)
2087		@	Flavoring Extracts and Flavoring Syrups NEC		
2087	pt		. Coffee Flavoring and Syrups	31192	Coffee and Tea Manufacturing (pt)
2087	pt		. Flavoring Syrup and Concentrate, Except Coffee	31193	Flavoring Syrup and Concentrate Manufacturing
2087	pt		. Flavoring Extracts, Except Coffee, and Natural Food Colorings	311942	Spice and Extract Manufacturing (pt)
2087	pt		. Powdered Drink Mix	311999	All Other Miscellaneous Food Manufacturing (pt)
2091		@	Canned and Cured Fish and Seafood	311711	Seafood Canning (pt)
2092		@	Prepared Fresh or Frozen Fish and Seafoods	311712	Fresh and Frozen Seafood Processing (pt)
2095		@	Roasted Coffee	31192	Coffee and Tea Manufacturing (pt)
2096		@	Potato Chips, Corn Chips, and Similar Snacks	311919	Other Snack Food Manufacturing (pt)
2097			Manufactured Ice	312113	Ice Manufacturing
2098			Macaroni, Spaghetti, Vermicelli, and Noodles	311823	Dry Pasta Manufacturing (pt)
2099			Food Preparations, NEC		
2099	pt		. Reducing Maple Sap to Maple Syrup	111998	All Other Miscellaneous Crop Farming (pt)
2099	pt		. Marshmallow Creme	31134	Nonchocolate Confectionery Manufacturing (pt)
2099	pt		. Peanut Butter	311911	Roasted Nuts and Peanut Butter Manufacturing (pt)
2099	pt		. Potatoes, Dried and Packaged with Other Ingredients Made in Dehydration Plants, and Bouillon	311423	Dried and Dehydrated Food Manufacturing (pt)
2099	pt		. Perishable Prepared Food	311991	Perishable Prepared Food Manufacturing
2099	pt		. Rice, Uncooked and Packaged with Other Ingredients Made in Rice Mills	311212	Rice Milling (pt)
2099	pt		. Tortillas	31183	Tortilla Manufacturing
2099	pt		. Dry Pasta Packaged with Other Ingredients Made in Dry Pasta Plants	311823	Dry Pasta Manufacturing (pt)
2099	pt		. Tea	31192	Coffee and Tea Manufacturing (pt)
2099	pt		. Vinegar, Prepared Dips Except Dairy and Cider	311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing (pt)
2099	pt		. Spices and Extracts	311942	Spice and Extract Manufacturing (pt)
2099	pt		. Other	311999	All Other Miscellaneous Food Manufacturing (pt)
21			Tobacco manufactures		
2111			Cigarettes	312221	Cigarette Manufacturing
2121			Cigars	312229	Other Tobacco Product Manufacturing (pt)
2131		@	Chewing and Smoking Tobacco and Snuff	312229	Other Tobacco Product Manufacturing (pt)
2141		@	Tobacco Stemming and Redrying		
2141	pt		. Reconstituted Tobacco	312229	Other Tobacco Product Manufacturing (pt)
2141	pt		. Redrying and Stemming	31221	Tobacco Stemming and Redrying
22			Textile mill products		
2211		@	Broadwoven Fabric Mills, Cotton	31321	Broadwoven Fabric Mills (pt)
2221		@	Broadwoven Fabric Mills, Manmade Fiber and Silk	31321	Broadwoven Fabric Mills (pt)
2231		@	Broadwoven Fabric Mills, Wool (Including Dyeing and Finishing)		
2231	pt		. Except Wool Finishing only	31321	Broadwoven Fabric Mills (pt)
2231	pt		. Wool Broadwoven Fabric Finishing only	313311	Broadwoven Fabric Finishing Mills (pt)
2231	pt		. Wool Finishing only, Except Broadwoven Fabric	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2241			Narrow Fabric and Other Smallware Mills: Cotton, Wool, Silk, and Manmade Fiber	313221	Narrow Fabric Mills (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2251		@	Women's Full-Length and Knee-Length Hosiery, Except Socks		
2251	pt		. Dyeing and Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2251	pt		. Except Dyeing and Finishing Only	315111	Sheer Hosiery Mills (pt)
2252			Hosiery, NEC		
2252	pt		. Dyeing and Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2252	pt		. Girls' Hosiery, Except Dyeing and Finishing Only	315111	Sheer Hosiery Mills (pt)
2252	pt		. Socks, Except Dyeing and Finishing Only	315119	Other Hosiery and Sock Mills
2253		@	Knit Outerwear Mills		
2253	pt		. Dyeing and Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2253	pt		. Bathrobes and Lounging Robes Made in Knitting Mills Except Dyeing and Finishing Only	315192	Underwear and Nightwear Knitting Mills (pt)
2253	pt		. Except Dyeing and Finishing Only and Bathrobes and Lounging Robes	315191	Outerwear Knitting Mills (pt)
2254			Knit Underwear and Nightwear Mills		
2254	pt		. Dyeing and Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2254	pt		. Except Dyeing and Finishing Only	315192	Underwear and Nightwear Knitting Mills (pt)
2257		@	Weft Knit Fabric Mills		
2257	pt		. Except Finishing	313241	Weft Knit Fabric Mills (pt)
2257	pt		. Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2258		@	Lace and Warp Knit Fabric Mills		
2258	pt		. Except Finishing	313249	Other Knit Fabric and Lace Mills (pt)
2258	pt		. Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2259		@	Knitting Mills, NEC		
2259	pt		. Knit Gloves and Mittens	315191	Outerwear Knitting Mills (pt)
2259	pt		. Girdles	315192	Underwear and Nightwear Knitting Mills (pt)
2259	pt		. Finished Articles of Weft Knit Fabric	313241	Weft Knit Fabric Mills (pt)
2259	pt		. Knit Gloves and Mittens, Dyeing and Finishing Only	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2259	pt		. Finished Articles of Warp Knit Fabric	313249	Other Knit Fabric and Lace Mills (pt)
2261		@	Finishers of Broadwoven Fabrics of Cotton	313311	Broadwoven Fabric Finishing Mills (pt)
2262		@	Finishers of Broadwoven Fabrics of Manmade Fiber and Silk	313311	Broadwoven Fabric Finishing Mills (pt)
2269		@	Finishers of Textiles, NEC	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2273			Carpets and Rugs	31411	Carpet and Rug Mills
2281		@	Yarn Spinning Mills	313111	Yarn Spinning Mills (pt)
2282			Yarn Texturizing, Throwing, Twisting, and Winding Mills	313112	Yarn Texturizing, Throwing, and Twisting Mills
2284		@	Thread Mills		
2284	pt		. Except Finishing	313113	Thread Mills (pt)
2284	pt		. Finishing	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2295		@	Coated Fabrics, Not Rubberized	31332	Fabric Coating Mills (pt)
2296			Tire Cord and Fabrics	314992	Tire Cord and Tire Fabric Mills
2297		@	Nonwoven Fabrics	31323	Nonwoven Fabric Mills (pt)
2298			Cordage and Twine	314991	Rope, Cordage, and Twine Mills
2299		@	Textile Goods, NEC		
2299	pt		. Broadwoven Fabric of Jute, Linen, Hemp, and Ramie and Handwoven	31321	Broadwoven Fabric Mills (pt)
2299	pt		. Nonwoven Felt	31323	Nonwoven Fabric Mills (pt)
2299	pt		. Finishing Thread and Yarn of Flax, Hemp, Jute, Linen, and Ramie	313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills (pt)
2299	pt		. Narrow Woven Fabric of Jute, Linen, Hemp, and Ramie	313221	Narrow Fabric Mills (pt)
2299	pt		. Thread of Hemp, Linen, and Ramie	313113	Thread Mills (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2299	pt		. Yarn of Flax, Hemp, Jute, and Ramie	313111	Yarn Spinning Mills (pt)
2299	pt		. Recovery and Processing of Fibers and Waste	314999	All Other Miscellaneous Textile Product Mills (pt)
23			Apparel and other textile products		
2311		@	Men's and Boys' Suits, Coats, and Overcoats		
2311	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2311	pt		. Except Contractors	315222	Men's and Boys' Cut and Sew Suit, Coat, and Overcoat Manufacturing (pt)
2321		@	Men's and Boys' Shirts, Except Work Shirts		
2321	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2321	pt		. Except Contractors	315223	Men's and Boys' Cut and Sew Shirt (except Work Shirt) Manufacturing (pt)
2322		@	Men's and Boys' Underwear and Nightwear		
2322	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2322	pt		. Except Contractors	315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing (pt)
2323			Men's and Boys' Neckwear		
2323	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2323	pt		. Except Contractors	315993	Men's and Boys' Neckwear Manufacturing
2325		@	Men's and Boys' Trousers and Slacks		
2325	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2325	pt		. Except Contractors	315224	Men's and Boys' Cut and Sew Trouser, Slack, and Jean Manufacturing (pt)
2326		@	Men's and Boys' Work Clothing		
2326	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2326	pt		. Except Contractors	315225	Men's and Boys' Cut and Sew Work Clothing Manufacturing
2329		@	Men's and Boys' Clothing, NEC		
2329	pt		. Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2329	pt		. Except Contractors	315228	Men's and Boys' Cut and Sew Other Outerwear Manufacturing (pt)
2329	pt		. Athletic Uniforms, Except Contractors	315299	All Other Cut and Sew Apparel Manufacturing (pt)
2331		@	Women's, Misses', and Juniors' Blouses and Shirts		
2331	pt		. Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2331	pt		. Except Contractors	315232	Women's and Girls' Cut and Sew Blouse and Shirt Manufacturing (pt)
2335		@	Women's, Misses', and Juniors' Dresses		
2335	pt		. Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2335	pt		. Except Contractors	315233	Women's and Girls' Cut and Sew Dress Manufacturing (pt)
2337		@	Women's, Misses' and Juniors' Suits, Skirts, and Coats		
2337	pt		. Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2337	pt		. Except Contractors	315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing (pt)
2339		@	Women's, Misses', and Juniors' Outerwear, NEC		
2339	pt		. Scarves, Except Contractors	315999	Other Apparel Accessories and Other Apparel Manufacturing (pt)
2339	pt		. Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2339	pt		. Athletic Uniforms, Except Contractors	315299	All Other Cut and Sew Apparel Manufacturing (pt)
2339	pt		. All Other, Except Contractors	315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing (pt)
2341		@	Women's, Misses', Children's, and Infants' Underwear and Nightwear		
2341	pt		. Women's, Girls' and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2341	pt		. Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2341	pt		. Women's and Girls', Except Contractors	315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing (pt)
2341	pt		. Boys', Except Contractors	315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2341	pt		. Infants', Except Contractors	315291	Infants' Cut and Sew Apparel Manufacturing (pt)
2342		@	Brassieres, Girdles, and Allied Garments		
2342	pt		. Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2342	pt		. Except contractors	315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing (pt)
2353			Hats, Caps, and Millinery		
2353	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2353	pt		. Women's, Girls', and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2353	pt		. Except Contractors	315991	Hat, Cap, and Millinery Manufacturing
2361		@	Girls', Children's, and Infants' Dresses, Blouses, and Shirts		
2361	pt		. Infants' Dresses, Blouses, and Shirts, Except Contractors	315291	Infants' Cut and Sew Apparel Manufacturing (pt)
2361	pt		. Boys' Shirts, Except Contractors	315223	Men's and Boys' Cut and Sew Shirt (except Work Shirt) Manufacturing (pt)
2361	pt		. Boys' Shirt Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2361	pt		. Girls' Blouses and Shirts, Except Contractors	315232	Women's and Girls' Cut and Sew Blouse and Shirt Manufacturing (pt)
2361	pt		. Girls' Dresses, Except Contractors	315233	Women's and Girls' Cut and Sew Dress Manufacturing (pt)
2361	pt		. Girls' and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2369		@	Girls', Children's, and Infants' Outerwear, NEC		
2369	pt		. Infants' Outerwear, NEC, Except Contractors	315291	Infants' Cut and Sew Apparel Manufacturing (pt)
2369	pt		. Boys' Suits and Coats, Except Contractors	315222	Men's and Boys' Cut and Sew Suit, Coat, and Overcoat Manufacturing (pt)
2369	pt		. Boys' Trousers and Slacks, Except Contractors	315224	Men's and Boys' Cut and Sew Trouser, Slack, and Jean Manufacturing (pt)
2369	pt		. Boys' Outerwear, NEC, Except Contractors	315228	Men's and Boys' Cut and Sew Other Outerwear Manufacturing (pt)
2369	pt		. Boys' Robes, Except Contractors	315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing (pt)
2369	pt		. Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2369	pt		. Girls' Suits, Coats, Skirts, Etc., Except Contractors	315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing (pt)
2369	pt		. Girls' Outerwear, NEC, Except Contractors	315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing (pt)
2369	pt		. Girls' Robes, Except Contractors	315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing (pt)
2369	pt		. Girls' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2371			Fur Goods		
2371	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2371	pt		. Women's, Girls', and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2371	pt		. Except Contractors	315292	Fur and Leather Apparel Manufacturing (pt)
2381		@	Dress and Work Gloves, Except Knit and All-Leather		
2381	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2381	pt		. Women's, Girls', and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2381	pt		. Except Contractors	315992	Glove and Mitten Manufacturing (pt)
2384		@	Robes and Dressing Gowns		
2384	pt		. Women's Except Contractors	315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing (pt)
2384	pt		. Men's Except Contractors	315221	Men's and Boys' Cut and Sew Underwear and Nightwear Manufacturing (pt)
2384	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2384	pt		. Women's and Girls' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2385		@	Waterproof Outerwear		
2385	pt		. Men's and Boys' Water Resistant or Water Repellent Tailored Overcoats	315222	Men's and Boys' Cut and Sew Suit, Coat, and Overcoat Manufacturing (pt)
2385	pt		. Women's and Girls' Water Resistant or Water Repellent Tailored Coats	315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2385	pt		. Men's and Boys' Water Resistant or Water Repellent Nontailored Outerwear, except Rubber and Plastics and Contractors	315228	Men's and Boys' Cut and Sew Other Outerwear Manufacturing (pt)
2385	pt		. Women's and Girls' Water Resistant or Water Repellent Nontailored Outerwear, except Rubber and Plastics and Contractors	315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing (pt)
2385	pt		. Infants' Waterproof Outerwear Except Contractors	315291	Infants' Cut and Sew Apparel Manufacturing (pt)
2385	pt		. Waterproof Rubber and Plastics Outerwear, Except Contractors	315299	All Other Cut and Sew Apparel Manufacturing (pt)
2385	pt		. Accessories such as Aprons, Bibs, and Miscellaneous Waterproof Items, Except Contractors	315999	Other Apparel Accessories and Other Apparel Manufacturing (pt)
2385	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2385	pt		. Women's and Girls' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2386		@	Leather and Sheep-Lined Clothing		
2386	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2386	pt		. Women's, Girls', and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2386	pt		. Except Contractors	315292	Fur and Leather Apparel Manufacturing (pt)
2387		@	Apparel Belts		
2387	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2387	pt		. Women's, Girls', and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2387	pt		. Except Contractors	315999	Other Apparel Accessories and Other Apparel Manufacturing (pt)
2389		@	Apparel and Accessories, NEC		
2389	pt		. Handkerchiefs, Arm bands, etc.	315999	Other Apparel Accessories and Other Apparel Manufacturing (pt)
2389	pt		. Academic and Clerical Outerwear	315299	All Other Cut and Sew Apparel Manufacturing (pt)
2389	pt		. Garters and Garter Belts	315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing (pt)
2389	pt		. Women's Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2389	pt		. Men's Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2391			Curtains and Draperies	314121	Curtain and Drapery Mills (pt)
2392		@	Housefurnishings, Except Curtains and Draperies		
2392	pt		. Blanket, Laundry, and Garment Storage Bags	314911	Textile Bag Mills (pt)
2392	pt		. Dust Rags	314999	All Other Miscellaneous Textile Product Mills (pt)
2392	pt		. Mops, Floor and Dust	339994	Broom, Brush, and Mop Manufacturing (pt)
2392	pt		. Other Housefurnishings	314129	Other Household Textile Product Mills (pt)
2393		@	Textile Bags	314911	Textile Bag Mills (pt)
2394			Canvas and Related Products	314912	Canvas and Related Product Mills (pt)
2395		@	Pleating, Decorative and Novelty Stitching, and Tucking for the Trade		
2395	pt		. Pleating and Stitching, Except Apparel Contractors	314999	All Other Miscellaneous Textile Product Mills (pt)
2395	pt		. Men's and Boys' Apparel Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
2395	pt		. Women's, Girls', and Infants' Apparel Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
2396		@	Automotive Trimmings, Apparel Findings, and Related Products		
2396	pt		. Textile Automotive Trimmings	33636	Motor Vehicle Seating and Interior Trim Manufacturing (pt)
2396	pt		. Apparel Findings and Trimmings	315999	Other Apparel Accessories and Other Apparel Manufacturing (pt)
2396	pt		. Printing and Embossing on Fabric Articles	323113	Commercial Screen Printing (pt)
2396	pt		. Other Apparel Products	314999	All Other Miscellaneous Textile Product Mills (pt)
2397			Schiffli Machine Embroideries	313222	Schiffli Machine Embroidery
2399			Fabricated Textile Products, NEC		
2399	pt		. Seat Belts and Seat and Tire Covers	33636	Motor Vehicle Seating and Interior Trim Manufacturing (pt)
2399	pt		. Apparel and Apparel Accessories	315999	Other Apparel Accessories and Other Apparel Manufacturing (pt)
2399	pt		. Other Fabricated Textile Products	314999	All Other Miscellaneous Textile Product Mills (pt)

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SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
24			Lumber and wood products		
2411			Logging	11331	Logging
2421		@	Sawmills and Planing Mills, General		
2421	pt		. Lumber Manufacturing from Purchased Lumber, Softwood Cut Stock, Wood Lath and Planing Mill Products	321912	Cut Stock, Resawing Lumber, and Planing (pt)
2421	pt		. Sawmills	321113	Sawmills (pt)
2421	pt		. Softwood Flooring	321918	Other Millwork (including Flooring) (pt)
2421	pt		. Kiln Drying	321999	All Other Miscellaneous Wood Product Manufacturing (pt)
2426			Hardwood Dimension and Flooring Mills		
2426	pt		. Hardwood Flooring	321918	Other Millwork (including Flooring) (pt)
2426	pt		. Wood Furniture Frames	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
2426	pt		. Hardwood Dimension Lumber Made From Logs and Bolts	321113	Sawmills (pt)
2426	pt		. Other Hardwood Dimension Except Flooring	321912	Cut Stock, Resawing Lumber, and Planing (pt)
2429		@	Special Product Sawmills, NEC		
2429	pt		. Shingle Mills, Shakes	321113	Sawmills (pt)
2429	pt		. Stave Manufacturing from Purchased Lumber	321912	Cut Stock, Resawing Lumber, and Planing (pt)
2429	pt		. Cooperage Stock	32192	Wood Container and Pallet Manufacturing (pt)
2429	pt		. Excelsior and Cooperage Headings	321999	All Other Miscellaneous Wood Product Manufacturing (pt)
2431			Millwork		
2431	pt		. Wood Windows and Doors	321911	Wood Window and Door Manufacturing
2431	pt		. Except Wood Windows and Doors	321918	Other Millwork (including Flooring) (pt)
2434			Wood Kitchen Cabinets	33711	Wood Kitchen Cabinet and Countertop Manufacturing (pt)
2435			Hardwood Veneer and Plywood	321211	Hardwood Veneer and Plywood Manufacturing
2436			Softwood Veneer and Plywood	321212	Softwood Veneer and Plywood Manufacturing
2439			Structural Wood Members, NEC		
2439	pt		. Trusses	321214	Truss Manufacturing
2439	pt		. Except Trusses	321213	Engineered Wood Member (except Truss) Manufacturing
2441			Nailed and Lock Corner Wood Boxes and Shook	32192	Wood Container and Pallet Manufacturing (pt)
2448			Wood Pallets and Skids	32192	Wood Container and Pallet Manufacturing (pt)
2449			Wood Containers, NEC	32192	Wood Container and Pallet Manufacturing (pt)
2451			Mobile Homes	321991	Manufactured Home (Mobile Home) Manufacturing
2452			Prefabricated Wood Buildings and Components	321992	Prefabricated Wood Building Manufacturing
2491			Wood Preserving	321114	Wood Preservation
2493			Reconstituted Wood Products	321219	Reconstituted Wood Product Manufacturing
2499			Wood Products, NEC		
2499	pt		. Mirror and Picture Frames	339999	All Other Miscellaneous Manufacturing (pt)
2499	pt		. Wood Cooling Towers	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing (pt)
2499	pt		. Wood Tubs and Vats, Jewelry, Cigar Boxes, and Baskets, Except Fruit, Fish, and Bait	32192	Wood Container and Pallet Manufacturing (pt)
2499	pt		. Other Wood Products	321999	All Other Miscellaneous Wood Product Manufacturing (pt)
25			Furniture and fixtures		
2511			Wood Household Furniture, Except Upholstered		
2511	pt		. Wood Box Spring Frames	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
2511	pt		. Except Wood Box Spring Frames	337122	Nonupholstered Wood Household Furniture Manufacturing (pt)
2512			Wood Household Furniture, Upholstered	337121	Upholstered Household Furniture Manufacturing (pt)
2514			Metal Household Furniture		

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2514	pt		. Except Upholstered and Metal Box Spring Frames	337124	Metal Household Furniture Manufacturing
2514	pt		. Upholstered	337121	Upholstered Household Furniture Manufacturing (pt)
2514	pt		. Metal Box Spring Frames	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
2515			Mattresses, Foundations, and Convertible Beds		
2515	pt		. Mattresses and Foundations	33791	Mattress Manufacturing
2515	pt		. Convertible Sofas	337121	Upholstered Household Furniture Manufacturing (pt)
2517			Wood Television, Radio, Phonograph and Sewing Machine Cabinets	337129	Wood Television, Radio, and Sewing Machine Cabinet Manufacturing
2519			Household Furniture, NEC	337125	Household Furniture (except Wood and Metal) Manufacturing
2521			Wood Office Furniture	337211	Wood Office Furniture Manufacturing
2522			Office Furniture, Except Wood	337214	Office Furniture (except Wood) Manufacturing
2531		@	Public Building and Related Furniture		
2531	pt		. Seats for Motor Vehicles	33636	Motor Vehicle Seating and Interior Trim Manufacturing (pt)
2531	pt		. Furniture Made for Public Buildings	337127	Institutional Furniture Manufacturing (pt)
2531	pt		. Blackboards	339942	Lead Pencil and Art Good Manufacturing (pt)
2541			Wood Office and Store Fixtures, Partitions, Shelving, and Lockers		
2541	pt		. Wood Lunchroom Tables and Chairs	337127	Institutional Furniture Manufacturing (pt)
2541	pt		. Custom Architectural Woodwork, Millwork and Fixtures	337212	Custom Architectural Woodwork and Millwork Manufacturing
2541	pt		. Except Countertops, Custom Architectural Woodwork, Millwork, and Fixtures	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
2542			Office and Store Fixtures, Partitions, Shelving, and Lockers, Except Wood		
2542	pt		. Lunchroom Tables and Chairs (except wood)	337127	Institutional Furniture Manufacturing (pt)
2542	pt		. Except Lunchroom Tables and Chairs (except wood)	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
2591			Drapery Hardware and Window Blinds and Shades	33792	Blind and Shade Manufacturing
2599		@	Furniture and Fixtures, NEC		
2599	pt		. Hospital Beds	339111	Laboratory Apparatus and Furniture Manufacturing (pt)
2599	pt		. Except Hospital Beds	337127	Institutional Furniture Manufacturing (pt)
26			Paper and allied products		
2611			Pulp Mills		
2611	pt		. Pulp Producing Mills Only	32211	Pulp Mills
2611	pt		. Pulp Mills Producing Paper	322121	Paper (except Newsprint) Mills (pt)
2611	pt		. Pulp Mills Producing Newsprint	322122	Newsprint Mills (pt)
2611	pt		. Pulp Mills Producing Paperboard	32213	Paperboard Mills (pt)
2621		@	Paper Mills		
2621	pt		. Except Newsprint Mills	322121	Paper (except Newsprint) Mills (pt)
2621	pt		. Newsprint Mills	322122	Newsprint Mills (pt)
2631			Paperboard Mills	32213	Paperboard Mills (pt)
2652			Setup Paperboard Boxes	322213	Setup Paperboard Box Manufacturing
2653			Corrugated and Solid Fiber Boxes	322211	Corrugated and Solid Fiber Box Manufacturing (pt)
2655			Fiber Cans, Tubes, Drums, and Similar Products	322214	Fiber Can, Tube, Drum, and Similar Products Manufacturing
2656			Sanitary Food Containers, Except Folding	322215	Nonfolding Sanitary Food Container Manufacturing
2657			Folding Paperboard Boxes, Including Sanitary	322212	Folding Paperboard Box Manufacturing
2671			Packaging Paper and Plastics Film, Coated and Laminated		
2671	pt		. Single-Web Paper, Paper Multiweb Laminated Rolls and Sheets for Packaging Uses	322221	Coated and Laminated Packaging Paper and Plastics Film Manufacturing
2671	pt		. Plastics Packaging Film and Sheet	326112	Unsupported Plastics Packaging Film and Sheet Manufacturing
2672			Coated and Laminated Paper, NEC	322222	Coated and Laminated Paper Manufacturing (pt)
2673			Plastics, Foil, and Coated Paper Bags		

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2673	pt		. Except All Plastics	322223	Plastics, Foil, and Coated Paper Bag Manufacturing
2673	pt		. Plastics Bags	326111	Unsupported Plastics Bag Manufacturing
2674			Uncoated Paper and Multiwall Bags	322224	Uncoated Paper and Multiwall Bag Manufacturing
2675		@	Die-Cut Paper and Paperboard and Cardboard		
2675	pt		. File Folders, Tabulating Cards, and Other Paper and Paperboard Office Supplies	322231	Die-Cut Paper and Paperboard Office Supplies Manufacturing (pt)
2675	pt		. Pasted, Lined, Laminated, or Surface-Coated Paperboard	322226	Surface-Coated Paperboard Manufacturing
2675	pt		. Die-Cut Paper and Paperboard Products, Except Office Supplies and Pasted, Lined, Laminated, or Surface-Coated Paperboard	322299	All Other Converted Paper Product Manufacturing (pt)
2676			Sanitary Paper Products	322291	Sanitary Paper Product Manufacturing (pt)
2677			Envelopes	322232	Envelope Manufacturing
2678			Stationery, Tablets, and Related Products	322233	Stationery, Tablet, and Related Product Manufacturing
2679		@	Converted Paper and Paperboard Products, NEC		
2679	pt		. Corrugated Paper	322211	Corrugated and Solid Fiber Box Manufacturing (pt)
2679	pt		. Wallpaper and Gift Wrap Paper	322222	Coated and Laminated Paper Manufacturing (pt)
2679	pt		. Paper Supplies for Business Machines and Other Paper Office Supplies	322231	Die-Cut Paper and Paperboard Office Supplies Manufacturing (pt)
2679	pt		. Other Converted Paper and Paperboard Products, such as Paper Filters, Crepe Paper, and Laminated and Tiled Wallboard	322299	All Other Converted Paper Product Manufacturing (pt)
27			Printing and publishing		
2711			Newspapers: Publishing, or Publishing and Printing	51111	Newspaper Publishers
2721			Periodicals: Publishing, or Publishing and Printing	51112	Periodical Publishers (pt)
2731			Books: Publishing, or Publishing and Printing		
2731	pt		. Music Book Publishing	51223	Music Publishers (pt)
2731	pt		. All Other Book Publishers	51113	Book Publishers
2732			Book Printing	323117	Books Printing
2741			Miscellaneous Publishing		
2741	pt		. Database Publishing	51114	Database and Directory Publishers (pt)
2741	pt		. Shopping News	51112	Periodical Publishers (pt)
2741	pt		. Technical Manuals and Books	51113	Book Publishers (pt)
2741	pt		. Sheet Music Publishers	51223	Music Publishers (pt)
2741	pt		. Miscellaneous Publishing, Except Database, Shopping News, Technical Manuals and Books, and Sheet Music	511199	All Other Publishers
2752		@	Commercial Printing, Lithographic		
2752	pt		. Quick Printing	323114	Quick Printing (pt)
2752	pt		. Except Quick Printing	323110	Commercial Lithographic Printing (pt)
2754			Commercial Printing, Gravure	323111	Commercial Gravure Printing (pt)
2759		@	Commercial Printing, NEC		
2759	pt		. Screen Printing	323113	Commercial Screen Printing (pt)
2759	pt		. Flexographic Printing	323112	Commercial Flexographic Printing (pt)
2759	pt		. Quick Printing	323114	Quick Printing (pt)
2759	pt		. Digital Printing,, except Quick Printing	323115	Digital Printing
2759	pt		. Other Commercial Printing	323119	Other Commercial Printing (pt)
2761			Manifold Business Forms	323116	Manifold Business Forms Printing (pt)
2771		@	Greeting Cards		
2771	pt		. Lithographic Printing of Greeting Cards	323110	Commercial Lithographic Printing (pt)
2771	pt		. Gravure Printing of Greeting Cards	323111	Commercial Gravure Printing (pt)
2771	pt		. Flexographic Printing of Greeting Cards	323112	Commercial Flexographic Printing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2771	pt		. Screen Printing of Greeting Cards	323113	Commercial Screen Printing (pt)
2771	pt		. Other Printing of Greeting Cards	323119	Other Commercial Printing (pt)
2771	pt		. Publishing Greeting Cards	511191	Greeting Card Publishers
2782		@	Blankbooks, Loose-leaf Binders and Devices		
2782	pt		. Printing of Checkbooks	323116	Manifold Business Forms Printing (pt)
2782	pt		. Blankbooks, Loose-leaf Binders and Devices	323118	Blankbook, Looseleaf Binders, and Devices Manufacturing
2789			Bookbinding and Related Work	323121	Tradebinding and Related Work
2791		@	Typesetting	323122	Prepress Services (pt)
2796		@	Platemaking and Related Services	323122	Prepress Services (pt)
28			Chemicals and allied products		
2812			Alkalies and Chlorine	325181	Alkalies and Chlorine Manufacturing
2813			Industrial Gases	32512	Industrial Gas Manufacturing (pt)
2816			Inorganic Pigments		
2816	pt		. Except Bone and Lamp Black	325131	Inorganic Dye and Pigment Manufacturing (pt)
2816	pt		. Bone and Lamp Black	325182	Carbon Black Manufacturing (pt)
2819		@	Industrial Inorganic Chemicals, NEC		
2819	pt		. Recovering Sulfur from Natural Gas	211112	Natural Gas Liquid Extraction (pt)
2819	pt		. Activated Carbon and Charcoal	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing (pt)
2819	pt		. Alumina	331311	Alumina Refining
2819	pt		. Inorganic Dyes	325131	Inorganic Dye and Pigment Manufacturing (pt)
2819	pt		. Other	325188	All Other Basic Inorganic Chemical Manufacturing (pt)
2821			Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers	325211	Plastics Material and Resin Manufacturing
2822			Synthetic Rubber	325212	Synthetic Rubber Manufacturing
2823			Cellulosic Manmade Fibers	325221	Cellulosic Organic Fiber Manufacturing
2824			Manmade Organic Fibers, Except Cellulosic	325222	Noncellulosic Organic Fiber Manufacturing
2833			Medicinal Chemicals and Botanical Products	325411	Medicinal and Botanical Manufacturing
2834			Pharmaceutical Preparations	325412	Pharmaceutical Preparation Manufacturing (pt)
2835		@	In Vitro and In Vivo Diagnostic Substances		
2835	pt		. Except In Vitro Diagnostic	325412	Pharmaceutical Preparation Manufacturing (pt)
2835	pt		. In Vitro Diagnostic Substances	325413	In-Vitro Diagnostic Substance Manufacturing
2836			Biological Products, Except Diagnostic Substances	325414	Biological Product (except Diagnostic) Manufacturing
2841			Soaps and Other Detergents, Except Speciality Cleaners	325611	Soap and Other Detergent Manufacturing (pt)
2842			Speciality Cleaning, Polishing, and Sanitary Preparations	325612	Polish and Other Sanitation Good Manufacturing
2843			Surface Active Agents, Finishing Agents, Sulfonated Oils, and Assistants	325613	Surface Active Agent Manufacturing
2844			Perfumes, Cosmetics, and Other Toilet Preparations		
2844	pt		. Toilet Preparations, Except Toothpaste	32562	Toilet Preparation Manufacturing
2844	pt		. Toothpaste	325611	Soap and Other Detergent Manufacturing (pt)
2851			Paints, Varnishes, Lacquers, Enamels, and Allied Products	32551	Paint and Coating Manufacturing (pt)
2861			Gum and Wood Chemicals	325191	Gum and Wood Chemical Manufacturing
2865		@	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments		
2865	pt		. Aromatics	32511	Petrochemical Manufacturing (pt)
2865	pt		. Organic Dyes and Pigments	325132	Synthetic Organic Dye and Pigment Manufacturing
2865	pt		. Other	325192	Cyclic Crude and Intermediate Manufacturing
2869		@	Industrial Organic Chemicals, NEC		
2869	pt		. Aliphatics	32511	Petrochemical Manufacturing (pt)
2869	pt		. Carbon Bisulfide	325188	All Other Basic Inorganic Chemical Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
2869	pt		. Ethyl Alcohol	325193	Ethyl Alcohol Manufacturing
2869	pt		. Fluorocarbon Gases	32512	Industrial Gas Manufacturing (pt)
2869	pt		. Other	325199	All Other Basic Organic Chemical Manufacturing (pt)
2873			Nitrogenous Fertilizers	325311	Nitrogenous Fertilizer Manufacturing
2874			Phosphatic Fertilizers	325312	Phosphatic Fertilizer Manufacturing
2875			Fertilizers, Mixing Only	325314	Fertilizer (Mixing Only) Manufacturing
2879			Pesticides and Agricultural Chemicals, NEC	32532	Pesticide and Other Agricultural Chemical Manufacturing
2891			Adhesives and Sealants	32552	Adhesive Manufacturing
2892			Explosives	32592	Explosives Manufacturing
2893			Printing Ink	32591	Printing Ink Manufacturing
2895			Carbon Black	325182	Carbon Black Manufacturing (pt)
2899			Chemicals and Chemical Preparations, NEC		
2899	pt		. Frit	32551	Paint and Coating Manufacturing (pt)
2899	pt		. Table Salt	311942	Spice and Extract Manufacturing (pt)
2899	pt		. Fatty Acids	325199	All Other Basic Organic Chemical Manufacturing (pt)
2899	pt		. Other	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing (pt)
29			Petroleum and coal products		
2911			Petroleum Refining	32411	Petroleum Refineries
2951			Asphalt Paving Mixtures and Blocks	324121	Asphalt Paving Mixture and Block Manufacturing
2952			Asphalt Felts and Coatings	324122	Asphalt Shingle and Coating Materials Manufacturing
2992			Lubricating Oils and Greases	324191	Petroleum Lubricating Oil and Grease Manufacturing
2999			Products of Petroleum and Coal, NEC	324199	All Other Petroleum and Coal Products Manufacturing (pt)
30			Rubber and miscellaneous plastics products		
3011			Tires and Inner Tubes	326211	Tire Manufacturing (except Retreading)
3021			Rubber and Plastics Footwear	316211	Rubber and Plastics Footwear Manufacturing
3052			Rubber and Plastics Hose and Belting	32622	Rubber and Plastics Hoses and Belting Manufacturing
3053			Gaskets, Packing, and Sealing Devices	339991	Gasket, Packing, and Sealing Device Manufacturing
3061			Molded, Extruded, and Lathe-Cut Mechanical Rubber Goods	326291	Rubber Product Manufacturing for Mechanical Use
3069			Fabricated Rubber Products, NEC		
3069	pt		. Rubberizing Fabric or Purchased Textile Products	31332	Fabric Coating Mills (pt)
3069	pt		. Rubber Pants and Raincoats	315299	All Other Cut and Sew Apparel Manufacturing (pt)
3069	pt		. Rubber Bibs, Aprons, and Bathing Caps	315999	Other Apparel Accessories and Other Apparel (pt)
3069	pt		. Rubber Gloves and Life Jackets	339113	Surgical Appliance and Supplies Manufacturing (pt)
3069	pt		. Rubber Wet Suits	33992	Sporting and Athletic Goods Manufacturing (pt)
3069	pt		. Rubber Toys, Except Dolls	339932	Game, Toy, and Children's Vehicle Manufacturing (pt)
3069	pt		. Rubber Resilient Floor Covering	326192	Resilient Floor Covering Manufacturing (pt)
3069	pt		. Other	326299	All Other Rubber Product Manufacturing
3081			Unsupported Plastics Film and Sheet	326113	Unsupported Plastics Film and Sheet (except Packaging) Manufacturing
3082			Unsupported Plastics Profile Shapes	326121	Unsupported Plastics Profile Shape Manufacturing (pt)
3083			Laminated Plastics Plate, Sheet, and Profile Shapes	32613	Laminated Plastics Plate, Sheet, and Shape Manufacturing
3084		@	Plastics Pipe	326122	Plastics Pipe and Pipe Fitting Manufacturing (pt)
3085			Plastics Bottles	32616	Plastics Bottle Manufacturing
3086			Plastics Foam Products		
3086	pt		. Urethane and Other Foam Products	32615	Urethane and Other Foam Product (except Polystyrene) Manufacturing
3086	pt		. Polystyrene Foam Products	32614	Polystyrene Foam Product Manufacturing
3087			Custom Compounding of Purchased Plastics Resins	325991	Custom Compounding of Purchased Resin

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3088			Plastics Plumbing Fixtures	326191	Plastics Plumbing Fixture Manufacturing
3089			Plastics Products, NEC		
3089	pt		. Pipe Fittings	326122	Plastics Pipe and Pipe Fitting Manufacturing (pt)
3089	pt		. Plastics Sausage Casings	326121	Unsupported Plastics Profile Shape Manufacturing (pt)
3089	pt		. Finished Plastics Furniture Parts	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
3089	pt		. Other	326199	All Other Plastics Product Manufacturing (pt)
31			Leather and leather products		
3111			Leather Tanning and Finishing	31611	Leather and Hide Tanning and Finishing (pt)
3131		@	Boot and Shoe Cut Stock and Findings		
3131	pt		. Wood Heels	321999	All Other Miscellaneous Wood Product Manufacturing (pt)
3131	pt		. Metal Buckles	339993	Fastener, Button, Needle, and Pin Manufacturing (pt)
3131	pt		. Except Wood Heels and Metal Buckles	316999	All Other Leather Good Manufacturing (pt)
3142			House Slippers	316212	House Slipper Manufacturing
3143			Men's Footwear, Except Athletic	316213	Men's Footwear (except Athletic) Manufacturing
3144			Women's Footwear, Except Athletic	316214	Women's Footwear (except Athletic) Manufacturing
3149			Footwear, Except Rubber, NEC	316219	Other Footwear Manufacturing
3151			Leather Gloves and Mittens		
3151	pt		. Men's and Boys' Contractors	315211	Men's and Boys' Cut and Sew Apparel Contractors (pt)
3151	pt		. Women's, Girls', and Infants' Contractors	315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors (pt)
3151	pt		. Except Contractors	315992	Glove and Mitten Manufacturing (pt)
3161			Luggage	316991	Luggage Manufacturing
3171			Women's Handbags and Purses	316992	Women's Handbag and Purse Manufacturing
3172			Personal Leather Goods, Except Women's Handbags and Purses	316993	Personal Leather Good (except Women's Handbag and Purse) Manufacturing
3199		@	Leather Goods, NEC	316999	All Other Leather Good Manufacturing (pt)
32			Stone, clay, glass, and concrete products		
3211			Flat Glass	327211	Flat Glass Manufacturing
3221			Glass Containers	327213	Glass Container Manufacturing
3229			Pressed and Blown Glass and Glassware, NEC	327212	Other Pressed and Blown Glass and Glassware Manufacturing
3231			Glass Products, Made of Purchased Glass	327215	Glass Product Manufacturing Made of Purchased Glass
3241			Cement, Hydraulic	32731	Cement Manufacturing
3251			Brick and Structural Clay Tile		
3251	pt		. Slumped Brick	327331	Concrete Block and Brick Manufacturing (pt)
3251	pt		. Except Slump Brick	327121	Brick and Structural Clay Tile Manufacturing
3253			Ceramic Wall and Floor Tile	327122	Ceramic Wall and Floor Tile Manufacturing
3255			Clay Refractories	327124	Clay Refractory Manufacturing
3259			Structural Clay Products, NEC	327123	Other Structural Clay Product Manufacturing
3261			Vitreous China Plumbing Fixtures and China and Earthenware Fittings and Bathroom Accessories	327111	Vitreous China Plumbing Fixture and China and Earthenware Bathroom Accessories Manufacturing
3262			Vitreous China Table and Kitchen Articles	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing (pt)
3263			Fine Earthenware (Whiteware) Table and Kitchen Articles	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing (pt)
3264			Porcelain Electrical Supplies	327113	Porcelain Electrical Supply Manufacturing
3269			Pottery Products, NEC	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing (pt)
3271			Concrete Block and Brick	327331	Concrete Block and Brick Manufacturing
3272		@	Concrete Products, Except Block and Brick		
3272	pt		. Dry Mixture Concrete	327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing (pt)
3272	pt		. Concrete Pipes	327332	Concrete Pipe Manufacturing

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3272	pt		. Other Concrete Products	32739	Other Concrete Product Manufacturing
3273			Ready-Mixed Concrete	32732	Ready-Mix Concrete Manufacturing
3274			Lime	32741	Lime Manufacturing
3275			Gypsum Products	32742	Gypsum Product Manufacturing (pt)
3281			Cut Stone and Stone Products	327991	Cut Stone and Stone Product Manufacturing
3291			Abrasive Products		
3291	pt		. Steel Wool With or Without Soap	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3291	pt		. Abrasive Products (Except Steel Wool With or Without Soap)	32791	Abrasive Product Manufacturing
3292			Asbestos Products		
3292	pt		. Asbestos Brake Linings and Pads	33634	Motor Vehicle Brake System Manufacturing (pt)
3292	pt		. Other Asbestos Products	327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing (pt)
3295			Minerals and Earths, Ground or Otherwise Treated		
3295	pt		. Grinding, Washing, Separating, etc. of Minerals in SIC 1455	212324	Kaolin and Ball Clay Mining (pt)
3295	pt		. Grinding, Washing, Separating, etc. of Minerals in SIC 1459	212325	Clay and Ceramic and Refractory Minerals Mining (pt)
3295	pt		. Grinding, Washing, Separating, etc. of Minerals in SIC 1479	212393	Other Chemical and Fertilizer Mineral Mining (pt)
3295	pt		. Grinding, Washing, Separating, etc. of Minerals in SIC 1499	212399	All Other Nonmetallic Mineral Mining (pt)
3295	pt		. Except Grinding, Washing, Separating, etc.	327992	Ground or Treated Mineral and Earth Manufacturing
3296			Mineral Wool	327993	Mineral Wool Manufacturing
3297			Nonclay Refractories	327125	Nonclay Refractory Manufacturing
3299		@	Nonmetallic Mineral Products, NEC		
3299	pt		. Clay Statuary	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing (pt)
3299	pt		. Moldings, Ornamental and Architectural Plaster Work, and Gypsum Statuary	32742	Gypsum Product Manufacturing (pt)
3299	pt		. Other Nonmetallic Mineral Products	327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing (pt)
33			Primary metal industries		
3312		@	Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills		
3312	pt		. Coke Ovens, Not Integrated With Steel Mills	324199	All Other Petroleum and Coal Products Manufacturing (pt)
3312	pt		. Hot Rolling Purchased Steel	331221	Rolled Steel Shape Manufacturing (pt)
3312	pt		. Except Coke Ovens Not Integrated with Steel Mills and Hot Rolling Purchased Steel	331111	Iron and Steel Mills (pt)
3313			Electrometallurgical Products, Except Steel	331112	Electrometallurgical Ferroalloy Product Manufacturing
3315		@	Steel Wiredrawing and Steel Nails and Spikes		
3315	pt		. Steel Wire Drawing	331222	Steel Wire Drawing
3315	pt		. Nails, Spikes, Paper Clips, and Wire, Not Made in Wire Drawing Plants	332618	Other Fabricated Wire Product Manufacturing (pt)
3316			Cold-Rolled Steel Sheet, Strip, and Bars	331221	Rolled Steel Shape Manufacturing (pt)
3317			Steel Pipe and Tubes	33121	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel
3321			Gray and Ductile Iron Foundries	331511	Iron Foundries (pt)
3322			Malleable Iron Foundries	331511	Iron Foundries (pt)
3324			Steel Investment Foundries	331512	Steel Investment Foundries
3325			Steel Foundries, NEC	331513	Steel Foundries (except Investment)
3331			Primary Smelting and Refining of Copper	331411	Primary Smelting and Refining of Copper
3334			Primary Production of Aluminum	331312	Primary Aluminum Production
3339			Primary Smelting and Refining of Nonferrous Metals, Except Copper and Aluminum	331419	Primary Smelting and Refining of Nonferrous Metal (except Copper and Aluminum)
3341		@	Secondary Smelting and Refining of Nonferrous Metals		
3341	pt		. Aluminum	331314	Secondary Smelting and Alloying of Aluminum (pt)
3341	pt		. Copper	331423	Secondary Smelting, Refining, and Alloying of Copper (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3341	pt		. Except Aluminum and Copper	331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum) (pt)
3351			Rolling, Drawing, and Extruding of Copper	331421	Copper Rolling, Drawing, and Extruding
3353			Aluminum Sheet, Plate, and Foil	331315	Aluminum Sheet, Plate, and Foil Manufacturing
3354			Aluminum Extruded Products	331316	Aluminum Extruded Product Manufacturing
3355			Aluminum Rolling and Drawing, NEC	331319	Other Aluminum Rolling and Drawing (pt)
3356			Rolling, Drawing, and Extruding of Nonferrous Metals, Except Copper and Aluminum	331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding (pt)
3357		@	Drawing and Insulating of Nonferrous Wire		
3357	pt		. Aluminum Wire Drawing	331319	Other Aluminum Rolling and Drawing (pt)
3357	pt		. Copper Wire Drawing	331422	Copper Wire (except Mechanical) Drawing
3357	pt		. Wire Drawing Except Copper or Aluminum	331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding (pt)
3357	pt		. Fiber Optic Cable - Insulating Only	335921	Fiber Optic Cable Manufacturing
3357	pt		. All Other	335929	Other Communication and Energy Wire Manufacturing
3363			Aluminum Die-Castings	331521	Aluminum Die-Casting Foundries
3364			Nonferrous Die-Castings, Except Aluminum	331522	Nonferrous (except Aluminum) Die-Casting Foundries
3365			Aluminum Foundries	331524	Aluminum Foundries (except Die-Casting)
3366			Copper Foundries	331525	Copper Foundries (except Die-Casting)
3369			Nonferrous Foundries, Except Aluminum and Copper	331528	Other Nonferrous Foundries (except Die-Casting)
3398			Metal Heat Treating	332811	Metal Heat Treating
3399		@	Primary Metal Products, NEC		
3399	pt		. Aluminum Powder, Paste, Flakes, etc.	331314	Secondary Smelting and Alloying of Aluminum (pt)
3399	pt		. Copper Powder, Flakes, Paste, etc.	331423	Secondary Smelting, Refining, and Alloying of Copper (pt)
3399	pt		. Other Nonferrous Powder, Paste, Flakes, etc.	331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum) (pt)
3399	pt		. Making Ferrous Metal Powder, Paste, and Flake From Purchased Iron or Steel	331221	Rolled Steel Shape Manufacturing (pt)
3399	pt		. Nonferrous Nails, Brads, Staples, etc.	332618	Other Fabricated Wire Product Manufacturing (pt)
3399	pt		. Laminated Steel	332813	Electroplating, Plating, Polishing, Anodizing, and Coloring (pt)
34			Fabricated metal products		
3411			Metal Cans	332431	Metal Can Manufacturing
3412			Metal Shipping Barrels, Drums, Kegs, and Pails	332439	Other Metal Container Manufacturing (pt)
3421			Cutlery		
3421	pt		. Except Tool-Type Shears	332211	Cutlery and Flatware (except Precious) Manufacturing (pt)
3421	pt		. Tool-Type Shears	332212	Hand and Edge Tool Manufacturing (pt)
3423			Hand and Edge Tools, Except Machine Tools and Handsaws	332212	Hand and Edge Tool Manufacturing (pt)
3425			Saw Blades and Handsaws	332213	Saw Blade and Handsaw Manufacturing
3429		@	Hardware, NEC		
3429	pt		. Fireplace Fixtures, Traps, Handcuffs and Leg Irons, Ladder Jacks, and Other Like Metal Products	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3429	pt		. Vacuum and Insulated Bottles, Jugs, and Chests	332439	Other Metal Container Manufacturing (pt)
3429	pt		. Turnbuckles and Hose Clamps	332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing (pt)
3429	pt		. Luggage and Utility Racks	336399	All Other Motor Vehicle Parts Manufacturing (pt)
3429	pt		. Fire Hose Nozzles and Couplings	332919	Other Metal Valve and Pipe Fitting Manufacturing (pt)
3429	pt		. Convertible Bed Sleeper Mechanisms and Chair Glides	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
3429	pt		. Other Hardware	33251	Hardware Manufacturing (pt)
3431			Enameled Iron and Metal Sanitary Ware	332998	Enameled Iron and Metal Sanitary Ware Manufacturing

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3432			Plumbing Fixture Fittings and Trim		
3432	pt		. Plumbing Fixture Fittings and Trim, Except Metal Shower Rods and Lawn Hose Nozzles	332913	Plumbing Fixture Fitting and Trim Manufacturing
3432	pt		. Lawn Hose Nozzles	332919	Other Metal Valve and Pipe Fitting Manufacturing (pt)
3432	pt		. Metal Shower Rods	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3433			Heating Equipment, Except Electric and Warm Air Furnaces	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing (pt)
3441			Fabricated Structural Metal	332312	Fabricated Structural Metal Manufacturing (pt)
3442			Metal Doors, Sash, Frames, Molding, and Trim Manufacturing	332321	Metal Window and Door Manufacturing (pt)
3443		@	Fabricated Plate Work (Boiler Shops)		
3443	pt		. Fabricated Plate Work and Metal Weldments	332313	Plate Work Manufacturing
3443	pt		. Power Boilers and Heat Exchanges	33241	Power Boiler and Heat Exchanger Manufacturing (pt)
3443	pt		. Heavy Gauge Tanks	33242	Metal Tank (Heavy Gauge) Manufacturing
3443	pt		. Metal Cooling Towers	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing (pt)
3444			Sheet Metal Work		
3444	pt		. Ducts, Flumes, Flooring. Siding, Dampers, etc.	332322	Sheet Metal Work Manufacturing
3444	pt		. Metal Bins and Vats	332439	Other Metal Container Manufacturing (pt)
3444	pt		. Cooling Towers	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing (pt)
3446			Architectural and Ornamental Metal Work	332323	Ornamental and Architectural Metal Work Manufacturing (pt)
3448			Prefabricated Metal Buildings and Components	332311	Prefabricated Metal Building and Component Manufacturing
3449		@	Miscellaneous Structural Metal Work		
3449	pt		. Custom Roll Forming	332114	Custom Roll Forming
3449	pt		. Fabricated Bar Joists and Concrete Reinforcing Bars	332312	Fabricated Structural Metal Manufacturing (pt)
3449	pt		. Curtain Wall	332321	Metal Window and Door Manufacturing (pt)
3449	pt		. Metal Plaster Bases	332323	Ornamental and Architectural Metal Work Manufacturing (pt)
3451			Screw Machine Products	332721	Precision Turned Product Manufacturing
3452			Bolts, Nuts, Screws, Rivets, and Washers	332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing (pt)
3462			Iron and Steel Forgings	332111	Iron and Steel Forging
3463			Nonferrous Forgings	332112	Nonferrous Forging
3465			Automotive Stamping	33637	Motor Vehicle Metal Stamping
3466			Crowns and Closures	332115	Crown and Closure Manufacturing
3469			Metal Stamping, NEC		
3469	pt		. Metal Stamping, NEC (Except Kitchen Utensils, Pots and Pans for Cooking, and Coins)	332116	Metal Stamping
3469	pt		. Kitchen Utensils and Pots and Pans for Cooking	332214	Kitchen Utensil, Pot, and Pan Manufacturing
3471			Electroplating, Plating, Polishing, Anodizing, and Coloring	332813	Electroplating, Plating, Polishing, Anodizing, and Coloring (pt)
3479			Coating, Engraving, and Allied Services, NEC		
3479	pt		. Jewelry Engraving and Etching, Costume Jewelry	339914	Costume Jewelry and Novelty Manufacturing (pt)
3479	pt		. Jewelry Engraving and Etching, Precious Metal	339911	Jewelry (except Costume) Manufacturing (pt)
3479	pt		. Silverware and Flatware Engraving and Etching	339912	Silverware and Hollowware Manufacturing (pt)
3479	pt		. Other Coating, Engraving and Allied Services	332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
3482			Small Arms Ammunition	332992	Small Arms Ammunition Manufacturing
3483			Ammunition, Except for Small Arms	332993	Ammunition (except Small Arms) Manufacturing
3484			Small Arms	332994	Small Arms Manufacturing (pt)
3489			Ordnance and Accessories, NEC	332995	Other Ordnance and Accessories Manufacturing
3491			Industrial Valves	332911	Industrial Valve Manufacturing
3492			Fluid Power Valves and Hose Fittings	332912	Fluid Power Valve and Hose Fitting Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3493			Steel Springs, Except Wire	332611	Spring (Heavy Gauge) Manufacturing
3494			Valves and Pipe Fittings, NEC		
3494	pt		. Except Metal Pipe Hangers and Supports	332919	Other Metal Valve and Pipe Fitting Manufacturing (pt)
3494	pt		. Metal Pipe Hangers and Supports	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3495			Wire Springs		
3495	pt		. Wire Springs (Except Watch and Clock Springs)	332612	Spring (Light Gauge) Manufacturing
3495	pt		. Watch and Clock Springs	334518	Watch, Clock, and Part Manufacturing (pt)
3496			Miscellaneous Fabricated Wire Products		
3496	pt		. Grocery Carts	333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing (pt)
3496	pt		. Except Grocery Carts	332618	Other Fabricated Wire Product Manufacturing (pt)
3497			Metal Foil and Leaf		
3497	pt		. Laminated Aluminum Foil Rolls/Sheets for Flexible Packaging Uses	322225	Laminated Aluminum Foil Manufacturing for Flexible Packaging Uses
3497	pt		. Foil and Foil Containers	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3498			Fabricated Pipe and Pipe Fittings	332996	Fabricated Pipe and Pipe Fitting Manufacturing
3499			Fabricated Metal Products, NEC		
3499	pt		. Metal Furniture Frames	337215	Showcase, Partition, Shelving, and Locker Manufacturing (pt)
3499	pt		. Metal Motor Vehicle Seat Frames	33636	Motor Vehicle Seating and Interior Trim Manufacturing (pt)
3499	pt		. Powder Metallurgy	332117	Powder Metallurgy Part Manufacturing
3499	pt		. Metal Boxes	332439	Other Metal Container Manufacturing (pt)
3499	pt		. Safe and Vault Locks	33251	Hardware Manufacturing (pt)
3499	pt		. Metal Aerosol Valves	332919	Other Metal Valve and Pipe Fitting Manufacturing (pt)
3499	pt		. Other Metal Products	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
35			Industrial machinery and equipment		
3511			Steam, Gas, and Hydraulic Turbines, and Turbine Generator Set Units	333611	Turbine and Turbine Generator Set Unit Manufacturing
3519			Internal Combustion Engines, NEC		
3519	pt		. Stationary Engine Radiators	336399	All Other Motor Vehicle Parts Manufacturing (pt)
3519	pt		. Except Stationary Engine Radiators	333618	Other Engine Equipment Manufacturing (pt)
3523		@	Farm Machinery and Equipment		
3523	pt		. Farm Machinery and Equipment (Except Corrals, Stalls, Holding Gates, Hand Hair Clippers for Animals, Farm Conveyors, and Elevators)	333111	Farm Machinery and Equipment Manufacturing
3523	pt		. Corrals, Stalls, Holding Gates	332323	Ornamental and Architectural Metal Work Manufacturing (pt)
3523	pt		. Hand Hair Clippers for Animals	332212	Hand and Edge Tool Manufacturing(pt)
3523	pt		. Farm Conveyors and Farm Elevators, Stackers, and Bale Throwers	333922	Conveyor and Conveying Equipment Manufacturing (pt)
3524			Lawn and Garden Tractors and Home Lawn and Garden Equipment		
3524	pt		. Lawn and Garden Tractors and Home Lawn and Garden Equipment (Except Nonpowered Lawnmowers)	333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing
3524	pt		. Nonpowered Lawnmowers	332212	Hand and Edge Tool Manufacturing (pt)
3531		@	Construction Machinery and Equipment		
3531	pt		. Railway Track Maintenance Equipment	33651	Railroad Rolling Stock Manufacturing (pt)
3531	pt		. Winches, Aerial Work Platforms, and Automotive Wrecker Hoists	333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing (pt)
3531	pt		. Other Construction Machinery and Equipment	33312	Construction Machinery Manufacturing
3532			Mining Machinery and Equipment, Except Oil and Gas Field Machinery and Equipment	333131	Mining Machinery and Equipment Manufacturing
3533			Oil and Gas Field Machinery and Equipment	333132	Oil and Gas Field Machinery and Equipment Manufacturing
3534			Elevators and Moving Stairways	333921	Elevator and Moving Stairway Manufacturing
3535			Conveyors and Conveying Equipment	333922	Conveyor and Conveying Equipment Manufacturing (pt)
3536			Overhead Traveling Cranes, Hoists, and Monorail Systems	333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3537			Industrial Trucks, Tractors, Trailers, and Stackers		
3537	pt		. Industrial Trucks, Tractors, Trailers, and Stackers (Except Metal Pallets and Air Cargo Containers)	333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing
3537	pt		. Metal Pallets	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3537	pt		. Metal Air Cargo Containers	332439	Other Metal Container Manufacturing (pt)
3541			Machine Tools, Metal Cutting Type	333512	Machine Tool (Metal Cutting Types) Manufacturing
3542			Machine Tools, Metal Forming Type	333513	Machine Tool (Metal Forming Types) Manufacturing
3543			Industrial Patterns	332997	Industrial Pattern Manufacturing
3544			Special Dies and Tools, Die Sets, Jigs and Fixtures, and Industrial Molds		
3544	pt		. Except Industrial Molds	333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing
3544	pt		. Industrial Molds	333511	Industrial Mold Manufacturing
3545		@	Cutting Tools, Machine Tool Accessories, and Machinists' Precision Measuring Devices		
3545	pt		. Cutting Tools, Machine Tool Accessories, and Machinists' Precision Measuring Devices (Except Precision Measuring Devices)	333515	Cutting Tool and Machine Tool Accessory Manufacturing
3545	pt		. Precision Measuring Devices	332212	Hand and Edge Tool Manufacturing (pt)
3546			Power-Driven Handtools	333991	Power-Driven Handtool Manufacturing
3547			Rolling Mill Machinery and Equipment	333516	Rolling Mill Machinery and Equipment Manufacturing
3548		@	Electric and Gas Welding and Soldering Equipment		
3548	pt		. Except Transformers for Arc-Welding	333992	Welding and Soldering Equipment Manufacturing
3548	pt		. Transformers for Arc-Welding	335311	Power, Distribution, and Specialty Transformer Manufacturing (pt)
3549			Metalworking Machinery, NEC	333518	Other Metalworking Machinery Manufacturing
3552			Textile Machinery	333292	Textile Machinery Manufacturing
3553			Woodworking Machinery	33321	Sawmill and Woodworking Machinery Manufacturing
3554			Paper Industries Machinery	333291	Paper Industry Machinery Manufacturing
3555			Printing Trades Machinery and Equipment	333293	Printing Machinery and Equipment Manufacturing
3556			Food Products Machinery	333294	Food Product Machinery Manufacturing
3559		@	Special Industry Machinery, NEC		
3559	pt		. Rubber and Plastics Manufacturing Machinery	33322	Plastics and Rubber Industry Machinery Manufacturing
3559	pt		. Nuclear Control Drive Mechanisms	33241	Power Boiler and Heat Exchanger Manufacturing (pt)
3559	pt		. Automotive Maintenance Equipment	333319	Other Commercial and Service Industry Machinery Manufacturing (pt)
3559	pt		. Semiconductor Machinery Manufacturing	333295	Semiconductor Machinery Manufacturing
3559	pt		. Cotton Ginning Machinery	333111	Farm Machinery and Equipment Manufacturing (pt)
3559	pt		. Except Rubber and Plastics Manufacturing Machinery, Semiconductor Manufacturing Machinery, Automotive Maintenance Equipment, Cotton Ginning Machinery, and Nuclear Control Device Mechanisms	333298	All Other Industrial Machinery Manufacturing (pt)
3561			Pumps and Pumping Equipment	333911	Pump and Pumping Equipment Manufacturing (pt)
3562			Ball and Roller Bearings	332991	Ball and Roller Bearing Manufacturing
3563			Air and Gas Compressors	333912	Air and Gas Compressor Manufacturing
3564			Industrial and Commercial Fans and Blowers and Air Purification Equipment		
3564	pt		. Air Purification Equipment	333411	Air Purification Equipment Manufacturing
3564	pt		. Fans and Blowers	333412	Industrial and Commercial Fan and Blower Manufacturing
3565			Packaging Machinery	333993	Packaging Machinery Manufacturing
3566			Speed Changers, Industrial High-Speed Drives, and Gears	333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing
3567			Industrial Process Furnaces and Ovens	333994	Industrial Process Furnace and Oven Manufacturing
3568			Mechanical Power Transmission Equipment, NEC	333613	Mechanical Power Transmission Equipment Manufacturing
3569			General Industrial Machinery and Equipment, NEC		

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3569	pt		. Electric Swimming Pool Heaters	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing (pt)
3569	pt		. Textile Fire Hose	314999	All Other Miscellaneous Textile Product Mills (pt)
3569	pt		. Except Electric Swimming Pool Heaters and Textile Fire Hoses	333999	All Other Miscellaneous General Purpose Machinery Manufacturing (pt)
3571			Electronic Computers	334111	Electronic Computer Manufacturing
3572			Computer Storage Devices	334112	Computer Storage Device Manufacturing
3575			Computer Terminals	334113	Computer Terminal Manufacturing
3577			Computer Peripheral Equipment, NEC		
3577	pt		. Plotter Controllers	334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing (pt)
3577	pt		. Magnetic Tape Cleaner	334613	Magnetic and Optical Recording Media Manufacturing (pt)
3577	pt		. Except Plotter Controllers and Magnetic Tape Cleaners	334119	Other Computer Peripheral Equipment Manufacturing (pt)
3578		@	Calculating and Accounting Machines, Except Electronic Computers		
3578	pt		. Point of Sales Terminals and Fund Transfer Devices	334119	Other Computer Peripheral Equipment Manufacturing (pt)
3578	pt		. Change Making Machines	333311	Automatic Vending Machine Manufacturing (pt)
3578	pt		. Calculating and Accounting Machines, Except Point of Sales Terminals and Fund Transfer Devices, and Change Making Machines	333313	Office Machinery Manufacturing (pt)
3579		@	Office Machines, NEC		
3579	pt		. Pencil Sharpeners, Staplers, and Other Office Equipment	339942	Lead Pencil and Art Good Manufacturing (pt)
3579	pt		. Time Clocks and Other Time Recording Devices	334518	Watch, Clock, and Part Manufacturing (pt)
3579	pt		. Other Office Machines	333313	Office Machinery Manufacturing (pt)
3581			Automatic Vending Machines	333311	Automatic Vending Machine Manufacturing
3582			Commercial Laundry, Drycleaning, and Pressing Machines	333312	Commercial Laundry, Drycleaning, and Pressing Machine Manufacturing
3585			Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment		
3585	pt		. Motor Vehicle Air-Conditioning	336391	Motor Vehicle Air-Conditioning Manufacturing
3585	pt		. Except Motor Vehicle Air-Conditioning	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
3586			Measuring and Dispensing Pumps	333913	Measuring and Dispensing Pump Manufacturing
3589			Service Industry Machinery, NEC	333319	Other Commercial and Service Industry Machinery Manufacturing (pt)
3592			Carburetors, Pistons, Piston Rings, and Valves	336311	Carburetor, Piston, Piston Ring, and Valve Manufacturing
3593			Fluid Power Cylinders and Actuators	333995	Fluid Power Cylinder and Actuator Manufacturing
3594			Fluid Power Pumps and Motors	333996	Fluid Power Pump and Motor Manufacturing
3596			Scales and Balances, Except Laboratory	333997	Scale and Balance (except Laboratory) Manufacturing
3599		@	Industrial and Commercial Machinery and Equipment, NEC		
3599	pt		. Gasoline, Oil and Intake Filters for Internal Combustion Engines, Except Motor Vehicle	336399	All Other Motor Vehicle Parts Manufacturing (pt)
3599	pt		. Flexible Metal Hose	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3599	pt		. Carnival Amusement Park Equipment	333319	Other Commercial and Service Industry Machinery Manufacturing (pt)
3599	pt		. Machine Shops	33271	Machine Shops
3599	pt		. Other Industrial and Commercial Machinery and Equipment	333999	All Other Miscellaneous General Purpose Machinery Manufacturing (pt)
36			Electrical and electronic equipment		
3612			Power, Distribution, and Specialty Transformers	335311	Power, Distribution, and Specialty Transformer Manufacturing (pt)
3613			Switchgear and Switchboard Apparatus	335313	Switchgear and Switchboard Apparatus Manufacturing
3621			Motors and Generators	335312	Motor and Generator Manufacturing (pt)
3624			Carbon and Graphite Products	335991	Carbon and Graphite Product Manufacturing
3625			Relays and Industrial Controls	335314	Relay and Industrial Control Manufacturing
3629			Electrical Industrial Apparatus, NEC	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing (pt)
3631			Household Cooking Equipment	335221	Household Cooking Appliance Manufacturing

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3632			Household Refrigerators and Home and Farm Freezers	335222	Household Refrigerator and Home Freezer Manufacturing
3633			Household Laundry Equipment	335224	Household Laundry Equipment Manufacturing
3634			Electric Housewares and Fans		
3634	pt		. Except Wall and Baseboard Heating Units for Permanent Installation, and Electronic Cigarette Lighters	335211	Electric Housewares and Household Fan Manufacturing
3634	pt		. Electronic Cigarette Lighters	339999	All Other Miscellaneous Manufacturing (pt)
3634	pt		. Wall and Baseboard Heating Units For Permanent Installation	333414	Heating Equipment (except Warm Air Furnaces) Manufacturing (pt)
3635			Household Vacuum Cleaners	335212	Household Vacuum Cleaner Manufacturing (pt)
3639			Household Appliances, NEC		
3639	pt		. Floor Waxing and Floor Polishing Machines	335212	Household Vacuum Cleaner Manufacturing (pt)
3639	pt		. Household Sewing Machines	333298	All Other Industrial Machinery Manufacturing (pt)
3639	pt		. Other Household Appliances	335228	Other Major Household Appliance Manufacturing
3641			Electric Lamp Bulbs and Tubes	33511	Electric Lamp Bulb and Part Manufacturing
3643			Current-Carrying Wiring Devices	335931	Current-Carrying Wiring Device Manufacturing
3644			Noncurrent-Carrying Wiring Devices		
3644	pt		. Fish Wire, Electrical Wiring Tool	332212	Hand and Edge Tool Manufacturing (pt)
3644	pt		. All Other Noncurrent-Carrying Wiring Devices	335932	Noncurrent-Carrying Wiring Device Manufacturing
3645			Residential Electric Lighting Fixtures	335121	Residential Electric Lighting Fixture Manufacturing (pt)
3646			Commercial, Industrial, and Institutional Electric Lighting Fixtures	335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing
3647			Vehicular Lighting Equipment	336321	Vehicular Lighting Equipment Manufacturing
3648		@	Lighting Equipment, NEC	335129	Other Lighting Equipment Manufacturing (pt)
3651			Household Audio and Video Equipment	33431	Audio and Video Equipment Manufacturing
3652			Phonograph Records and Prerecorded Audio Tapes and Disks		
3652	pt		. Reproduction of Recording Media	334612	Prerecorded Compact Disc (except Software), Tape, and Record Reproducing (pt)
3652	pt		. Integrated Record Companies, Except Duplication Only	51222	Integrated Record Production/Distribution
3661			Telephone and Telegraph Apparatus		
3661	pt		. Telephone and Telegraph Apparatus, Except Consumer External Modems	33421	Telephone Apparatus Manufacturing
3661	pt		. Consumer External Modems	334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing (pt)
3663			Radio and Television Broadcasting and Communications Equipment	33422	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing (pt)
3669			Communications Equipment, NEC	33429	Other Communications Equipment Manufacturing
3671			Electron Tubes	334411	Electron Tube Manufacturing
3672			Printed Circuit Boards	334412	Bare Printed Circuit Board Manufacturing
3674			Semiconductors and Related Devices	334413	Semiconductor and Related Device Manufacturing
3675			Electronic Capacitors	334414	Electronic Capacitor Manufacturing
3676			Electronic Resistors	334415	Electronic Resistor Manufacturing
3677			Electronic Coils, Transformers, and Other Inductors	334416	Electronic Coil, Transformer, and Other Inductor Manufacturing (pt)
3678			Electronic Connectors	334417	Electronic Connector Manufacturing
3679			Electronic Components, NEC		
3679	pt		. Antennas	33422	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing (pt)
3679	pt		. Radio Headphones	33431	Audio and Video Equipment Manufacturing (pt)
3679	pt		. Printed Circuit/Electronics Assembly	334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing (pt)
3679	pt		. Other Electronic Components	334419	Other Electronic Component Manufacturing
3691			Storage Batteries	335911	Storage Battery Manufacturing
3692			Primary Batteries, Dry and Wet	335912	Primary Battery Manufacturing
3694			Electrical Equipment for Internal Combustion Engines	336322	Other Motor Vehicle Electrical and Electronic Equipment Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3695			Magnetic and Optical Recording Media	334613	Magnetic and Optical Recording Media Manufacturing
3699			Electrical Machinery, Equipment, and Supplies, NEC		
3699	pt		. Electronic Teaching Machines and Flight Simulators	333319	Other Commercial and Service Industry Machinery Manufacturing (pt)
3699	pt		. Outboard Electric Motors	333618	Other Engine Equipment Manufacturing (pt)
3699	pt		. Laser Welding and Soldering Equipment	333992	Welding and Soldering Equipment Manufacturing (pt)
3699	pt		. Other Lasers		Classify According to Function
3699	pt		. Christmas Tree Lighting Sets, Electric Insect Lamps, Electric Fireplace Logs, and Trouble Lights	335129	Other Lighting Equipment Manufacturing (pt)
3699	pt		. Other Electrical Machinery, Equipment, and Supplies	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing (pt)
37			Transportation equipment		
3711		@	Motor Vehicles and Passenger Car Bodies		
3711	pt		. Automobiles	336111	Automobile Manufacturing
3711	pt		. Light Truck and Utility Vehicles	336112	Light Truck and Utility Vehicle Manufacturing
3711	pt		. Heavy Duty Trucks	33612	Heavy Duty Truck Manufacturing
3711	pt		. Kit Car and Other Passenger Car Bodies	336211	Motor Vehicle Body Manufacturing (pt)
3711	pt		. Military Armored Vehicles	336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing (pt)
3713			Truck and Bus Bodies	336211	Motor Vehicle Body Manufacturing (pt)
3714		@	Motor Vehicle Parts and Accessories		
3714	pt		. Dump-Truck Lifting Mechanisms and Fifth Wheels	336211	Motor Vehicle Body Manufacturing (pt)
3714	pt		. Gasoline Engines Including Rebuilt and Engine Parts Including Rebuilt for Motor Vehicles	336312	Gasoline Engine and Engine Parts Manufacturing
3714	pt		. Wiring Harness Sets, Other than Ignition; Block Heaters and Battery Heaters; Instrument Board Assemblies; Permanent Defroster; Windshield Washer-Wiper Mechanisms; Cruise Control Mechanisms; and Other Electrical Equipment for Internal Combustion Engin	336322	Other Motor Vehicle Electrical and Electronic Equipment Manufacturing (pt)
3714	pt		. Steering and Suspension Parts	33633	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
3714	pt		. Brake and Brake Systems, Including Assemblies	33634	Motor Vehicle Brake System Manufacturing (pt)
3714	pt		. Transmissions and Power Train Parts, Including Rebuilding	33635	Motor Vehicle Transmission and Power Train Parts Manufacturing
3714	pt		. Other Motor Vehicle Parts	336399	All Other Motor Vehicle Parts Manufacturing (pt)
3715			Truck Trailers	336212	Truck Trailer Manufacturing
3716			Motor Homes	336213	Motor Home Manufacturing
3721			Aircraft		
3721	pt		. Research and Development	54171	Research and Development in the Physical, Engineering, and Life Sciences (pt)
3721	pt		. Except Research and Development	336411	Aircraft Manufacturing (pt)
3724			Aircraft Engines and Engine Parts		
3724	pt		. Except Research and Development	336412	Aircraft Engine and Engine Parts Manufacturing (pt)
3724	pt		. Research and Development	54171	Research and Development in the Physical, Engineering, and Life Sciences (pt)
3728			Aircraft Parts and Auxiliary Equipment, NEC		
3728	pt		. Fluid Power Aircraft Subassemblies	332912	Fluid Power Valve and Hose Fitting Manufacturing (pt)
3728	pt		. Research and Development	54171	Research and Development in the Physical, Engineering, and Life Sciences (pt)
3728	pt		. Target Drones	336411	Aircraft Manufacturing (pt)
3728	pt		. Except Fluid Power Aircraft Subassemblies, Target Drones, and Research and Development	336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing
3731			Ship Building and Repairing		
3731	pt		. Floating Dry Docks Not Associated With Shipyards	48839	Other Support Activities for Water Transportation (pt)
3731	pt		. Ship Building and Repairing Except Floating Dry Docks Not Associated With	336611	Ship Building and Repairing

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
			Shipyards		
3732			Boat Building and Repairing		
3732	pt		. Boat Repair	81149	Other Personal and Household Goods Repair and Maintenance (pt)
3732	pt		. Boat Building	336612	Boat Building
3743			Railroad Equipment		
3743	pt		. Locomotive Fuel Lubricating or Cooling Medium Pumps	333911	Pump and Pumping Equipment Manufacturing (pt)
3743	pt		. Other Railroad Equipment	33651	Railroad Rolling Stock Manufacturing (pt)
3751			Motorcycles, Bicycles, and Parts	336991	Motorcycle, Bicycle, and Parts Manufacturing (pt)
3761			Guided Missiles and Space Vehicles		
3761	pt		. Except Research and Development	336414	Guided Missile and Space Vehicle Manufacturing
3761	pt		. Research and Development	54171	Research and Development in the Physical, Engineering, and Life Sciences (pt)
3764			Guided Missile and Space Vehicle Propulsion Units and Propulsion Unit Parts		
3764	pt		. Except Research and Development	336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
3764	pt		. Research and Development	54171	Research and Development in the Physical, Engineering, and Life Sciences (pt)
3769			Guided Missile Space Vehicle Parts and Auxiliary Equipment, NEC		
3769	pt		. Except Research and Development	336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
3769	pt		. Research and Development	54171	Research and Development in the Physical, Engineering, and Life Sciences (pt)
3792			Travel Trailers and Campers	336214	Travel Trailer and Camper Manufacturing (pt)
3795			Tanks and Tank Components	336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing (pt)
3799		@	Transportation Equipment, NEC		
3799	pt		. Automobile, Boat, Utility and Light Truck Trailers	336214	Travel Trailer and Camper Manufacturing (pt)
3799	pt		. Trailer Hitches	336399	All Other Motor Vehicle Parts Manufacturing (pt)
3799	pt		. Wheelbarrows	333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing (pt)
3799	pt		. Other Transportation Equipment	336999	All Other Transportation Equipment Manufacturing
38			Instruments and related products		
3812			Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments	334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
3821			Laboratory Apparatus and Furniture	339111	Laboratory Apparatus and Furniture Manufacturing (pt)
3822			Automatic Controls for Regulating Residential and Commercial Environments and Appliances	334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use
3823			Industrial Instruments for Measurement, Display, and Control of Process Variables; and Related Products	334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
3824			Totalizing Fluid Meters and Counting Devices	334514	Totalizing Fluid Meter and Counting Device Manufacturing (pt)
3825			Instruments for Measuring and Testing of Electricity and Electrical Signals		
3825	pt		. Automotive Ammeters and Voltmeters	334514	Totalizing Fluid Meter and Counting Device Manufacturing (pt)
3825	pt		. Except Automotive Ammeters and Voltmeters	334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
3826			Laboratory Analytical Instruments	334516	Analytical Laboratory Instrument Manufacturing
3827			Optical Instruments and Lenses	333314	Optical Instrument and Lens Manufacturing
3829			Measuring and Controlling Devices, NEC		
3829	pt		. Motor Vehicle Gauges	334514	Totalizing Fluid Meter and Counting Device Manufacturing (pt)
3829	pt		. Medical Thermometers	339112	Surgical and Medical Instrument Manufacturing (pt)
3829	pt		. Electronic Chronometers	334518	Watch, Clock, and Part Manufacturing
3829	pt		. Except Medical Thermometers, Electronic Chronometers, and Motor Vehicle Gauges	334519	Other Measuring and Controlling Device Manufacturing

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3841			Surgical and Medical Instruments and Apparatus		
3841	pt		. Tranquilizer Guns	332994	Small Arms Manufacturing (pt)
3841	pt		. Operating Tables	339111	Laboratory Apparatus and Furniture Manufacturing (pt)
3841	pt		. Except Tranquilizer Guns and Operating Tables	339112	Surgical and Medical Instrument Manufacturing (pt)
3842		@	Orthopedic, Prosthetic, and Surgical Appliances and Supplies		
3842	pt		. Incontinent and Bed Pads	322291	Sanitary Paper Product Manufacturing (pt)
3842	pt		. Orthopedic, Prosthetic, and Surgical Appliances and Supplies, except Electronic Hearing Aids	339113	Surgical Appliance and Supplies Manufacturing
3842	pt		. Electronic Hearing Aids	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing (pt)
3843			Dental Equipment and Supplies	339114	Dental Equipment and Supplies Manufacturing
3844			X-Ray Apparatus and Tubes and Related Irradiation Apparatus	334517	Irradiation Apparatus Manufacturing (pt)
3845			Electromedical and Electrotherapeutic Apparatus		
3845	pt		. CT and CAT Scanners	334517	Irradiation Apparatus Manufacturing (pt)
3845	pt		. Other Electromedical and Electrotherapeutic Apparatus	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing (pt)
3851			Ophthalmic Goods		
3851	pt		. Intra Ocular Lenses	339113	Surgical Appliance and Supplies Manufacturing (pt)
3851	pt		. Except Intra Ocular Lenses	339115	Ophthalmic Goods Manufacturing (pt)
3861			Photographic Equipment and Supplies		
3861	pt		. Photographic Equipment and Supplies (Except Photographic Film, Paper, Plates and Chemicals)	333315	Photographic and Photocopying Equipment Manufacturing
3861	pt		. Photographic Film, Paper, Plates and Chemicals	325992	Photographic Film, Paper, Plate, and Chemical Manufacturing
3873			Watches, Clocks, Clockwork Operated Devices and Parts	334518	Watch, Clock, and Part Manufacturing (pt)
39			Miscellaneous manufacturing industries		
3911			Jewelry, Precious Metal	339911	Jewelry (except Costume) Manufacturing (pt)
3914			Silverware, Plated Ware, and Stainless Steel Ware		
3914	pt		. Cutlery and Flatware Nonprecious and Precious Plated	332211	Cutlery and Flatware (except Precious) Manufacturing (pt)
3914	pt		. Precious Plated Hollowware	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3914	pt		. Silverware, Plated Ware, and Stainless Steel Ware (Except Nonprecious and Precious Plated Metal Cutlery and Flatware)	339912	Silverware and Hollowware Manufacturing (pt)
3915			Jewelers' Findings and Materials, and Lapidary Work		
3915	pt		. Watch Jewels	334518	Watch, Clock, and Part Manufacturing (pt)
3915	pt		. Except Watch Jewels	339913	Jewelers' Material and Lapidary Work Manufacturing
3931			Musical Instruments	339992	Musical Instrument Manufacturing
3942			Dolls and Stuffed Toys	339931	Doll and Stuffed Toy Manufacturing
3944			Games, Toys, and Children's Vehicles, Except Dolls and Bicycles		
3944	pt		. Metal Tricycles	336991	Motorcycle, Bicycle, and Parts Manufacturing (pt)
3944	pt		. Other Games, Toys, and Children's Vehicles	339932	Game, Toy, and Children's Vehicle Manufacturing
3949			Sporting and Athletic Goods, NEC	33992	Sporting and Athletic Goods Manufacturing
3951			Pens, Mechanical Pencils, and Parts	339941	Pen and Mechanical Pencil Manufacturing
3952		@	Lead Pencils, Crayons, and Artist's Materials		
3952	pt		. Drafting Tables and Boards	337127	Institutional Furniture Manufacturing (pt)
3952	pt		. Drawing and India Ink	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing (pt)
3952	pt		. Other	339942	Lead Pencil and Art Good Manufacturing (pt)
3953			Marking Devices	339943	Marking Device Manufacturing
3955			Carbon Paper and Inked Ribbons	339944	Carbon Paper and Inked Ribbon Manufacturing
3961			Costume Jewelry and Costume Novelties, Except Precious Metals	339914	Costume Jewelry and Novelty Manufacturing (pt)
3965			Fasteners, Buttons, Needles, and Pins	339993	Fastener, Button, Needle, and Pin Manufacturing (pt)

Table A-1
SIC Code to NAICS Code Mapping for Industry

SIC	Part	Break	SIC Description	NAICS	NAICS Description
3991			Brooms and Brushes	339994	Broom, Brush, and Mop Manufacturing (pt)
3993			Signs and Advertising Specialties		
3993	pt		. Signs	33995	Sign Manufacturing
3993	pt		. Advertising Specialties		Classified According to the Product Produced
3995			Burial Caskets	339995	Burial Casket Manufacturing
3996			Linoleum, Asphalted-Felt-Base, and Other Hard Surface Floor Coverings, NEC	326192	Resilient Floor Covering Manufacturing (pt)
3999			Manufacturing Industries, NEC		
3999	pt		. Beauty and Barber Chairs	337127	Institutional Furniture Manufacturing (pt)
3999	pt		. Other Beauty and Barber Shop Equipment	333319	Other Commercial and Service Industry Machinery Manufacturing (pt)
3999	pt		. Fur Dressing and Bleaching	31611	Leather and Hide Tanning and Finishing (pt)
3999	pt		. Lamp Shades of Paper or Textile	335121	Residential Electric Lighting Fixture Manufacturing (pt)
3999	pt		. Matches	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing (pt)
3999	pt		. Metal Products, Such As Combs, Hair Curlers, Etc.	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing (pt)
3999	pt		. Plastics Products, Such As Combs, Hair Curlers, Etc.	326199	All Other Plastics Product Manufacturing (pt)
3999	pt		. Electric Hair Clippers for Humans	335211	Electric Housewares and Household Fan Manufacturing (pt)
3999	pt		. Tape Measures	332212	Hand and Edge Tool Manufacturing (pt)
3999	pt		. Human Hair Clippers, Hand Operated	332211	Cutlery and Flatware (except Precious) Manufacturing (pt)
3999	pt		. Embroidery Kits	339932	Game, Toy, and Children's Vehicle Manufacturing (pt)
3999	pt		. Other	339999	All Other Miscellaneous Manufacturing (pt)

The abbreviation “pt” means “part of”; @ means time series break has been created that is greater than 3% of the 1992 value of shipments for the 1987 industry. The abbreviation NEC is used for Not Elsewhere Classified.

B PY2001 NONRESIDENTIAL PROGRAMS

This appendix contains a memorandum describing the PY2001 nonresidential energy-efficiency programs. The memorandum was prepared as part of a nonresidential energy-efficiency study being conducted in parallel to this industrial characterization study.

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- MEMORANDUM -

TO: Chris Ann Dickerson, PG&E

FROM: Kathleen McElroy, XENERGY

DATE: August 15, 2001

RE: PY2001 Nonresidential Energy Efficiency Program Summaries

CC: Mike Rufo, XENERGY

This memo provides a brief overview of nonresidential energy efficiency programs offered by the California investor-owned utilities (IOUs) in PY2001. This summary includes both statewide and utility-specific programs, and highlights third-party initiatives and Summer Initiative projects.

We have gathered information on PY2001 budgets and energy savings/demand reduction targets through our review of utility filings, PY2001 1st Quarterly Reports, and program manager interviews.

B.1 COMMON PROGRAMS

There are a number of programs – both statewide and utility-specific – that are common to all utilities. Table 1 lists these program categories, and summarizes budgets and energy savings/demand reduction targets by utility for PY2001. The following describes each common program activity.

B.1.1 Standard Performance Contract (SPC)

Over $25 million has been allocated to the Statewide Standard Performance Contract (SPC) Program in PY2001. Offered by PG&E, SCE and SDG&E in 2001, this performance-based program provides financial incentives to customers or EESPs for installation of energy efficient equipment. The program is targeted to both large, and small/medium customers within the commercial, industrial and agricultural segments. Incentives are provided for a variety of nonresidential end-uses, including HVAC, lighting, water heating, and other building-type specific end-uses. Utilities use EESPs and account reps to promote the program. Both the large and the small/medium program elements are standardized statewide, although there are some differences that reflect different service territory needs.

B.1.2 Express Efficiency

With an annual budget of over $41 million statewide, the Express Efficiency Program is the largest nonresidential energy efficiency program in PY2001. All four utilities offer customer rebates through the Express Efficiency Program, targeting small and medium nonresidential customers and addressing HVAC, lighting, refrigeration, water heating, and other building-type specific end-uses. In 2001, PG&E and SCE also target large customers with Express Efficiency incentives. Generally, the utilities use a combination of utility representatives, vendors, and contractors to deliver the program to nonresidential customers.

B.1.3 Energy Audits

All four utilities offer some form of energy audit program; that is, a program that provides customers with site-specific energy efficiency information designed to help them reduce their energy bills. Utilities have allocated 2-6% of their overall nonresidential program budgets to these programs. These energy audits, or "surveys," often provide an opportunity to introduce the utilities' other energy efficiency programs such as Express Efficiency. Each utility offers a variety of survey types, including on-site, on-line, direct mail, and phone.

B.1.4 HVAC Programs

SCE, SDG&E, SCG and PG&E offer upstream financial incentives to HVAC market actors to encourage the installation of energy efficient HVAC equipment in the nonresidential sectors. Most of these programs involve offering financial incentives to HVAC distributors and/or installation contractors to encourage greater supply of energy efficient HVAC equipment and to influence the ultimate customers' HVAC purchase decisions. SCE tracks the budget for marketing to and networking with upstream HVAC market actors under this program category, but the incentives are actually included within SCE's budget for Express Efficiency. The following table summarizes each utility's Upstream HVAC Program and provides PY2001 budget information.

Utility	Program Name	Description	PY2001 Budget
SCE	Nonresidential Upstream HVAC Pilot	Targets HVAC installation contractors with "quick start bonus" incentives to influence small/medium customer HVAC purchase decisions	$70,000 (Incentives offered through Express Efficiency
SDG&E	Midstream HVAC Incentives	Provides incentives to contractors to promote and install high efficiency HVAC equipment	$400,000
SCG	Small Commercial Upstream Gas Air Conditioning Program	Promotes gas air conditioning projects	$708,000
	Nonresidential HVAC Training	Provides training to HVAC contractors in proper installation of gas cooling systems	$147,000
PG&E	Nonresidential HVAC Turnover	Provides incentives to HVAC distributors	$2,000,000

B.1.5 Upstream Motor Programs

SCE, SDG&E and PG&E offer programs designed to encourage premium efficiency motor stocking and sales. These programs provide incentives to motor distributors. The following table summarizes each utility's Upstream Motors Program and provides PY2001 budget information.

Utility	Program name	Description	PY2001 Budget
SCE	Nonresidential Upstream Motors Pilot	Targets motor distributors with incentives to encourage premium efficiency motor stocking and sales	$330,000
SDG&E	Upstream Motors Incentives	Provides incentives to motor distributors to encourage premium efficiency stocking and sales	$123,000
PG&E	Nonresidential Motor Turnover	Provides incentives to motor distributors to encourage premium efficiency motor stocking and sales	$1,000,000

B.1.6 Process Overhaul Programs

SCE, SDG&E, SCG and PG&E offer programs designed to increase the level of energy-efficient process overhauls among nonresidential customers. Most of these programs provide specialized, technical consulting services to study opportunities related to customer process loads. SCE's program targets process load-improvements, but is delivered and funded through other nonresidential programs. The following table summarizes each utility's Process Overhaul Programs and provides PY2001 budget information.

Utility	Program Name	Description	PY2001 Budget
SCE	Nonresidential Process	Uses other programs to deliver and fund targeted process-load improvements	$0 (budget included in other programs)
SDG&E	Technical Assistance, Process	Provides technical consultants to conduct study of process load improvements	$297,000
SCG	Furnace/Kiln/Oven Program	Provides audits and incentives to stimulate efficiency investments in industrial process equipment	$1,418,000
	Process Energy Conservation Program	Provides audits and incentives to encourage adoption of unique process equipment not covered through other programs	$2,305,000
	Advanced Engine Technology Program	Provides audits and incentives to improve availability of gas-fired engine-driven end-uses	$1,074,000
PG&E	Compressed Air Management Program	Provides analysis of compressed air management systems to identify low-cost/no-cost improvements	$300,000

B.2 INFORMATION, OUTREACH, AND TECHNICAL SUPPORT

B.2.1 Business Energy Guide

PG&E, SCE, SDG&E and SCG distribute the statewide Business Energy Guides to small, nonresidential customers. (All but PG&E still show line-item budget funding for this program element in PY2001.) The Energy Guides provide energy information and education to customers to better manage their business energy costs. The Energy Guides provide energy information for office buildings, grocery stores, restaurants, retail outlets, and manufacturing facilities. Statewide, the Energy Guides are currently available in English, Spanish and Chinese. SCE has developed several other non-English language versions of the Energy Guides. The Energy Guides are delivered through targeted marketing efforts focused on small commercial businesses, relevant business trade/vendor shows, Small Business Associations, Chambers of Commerce, building permits and government offices, etc.

B.2.2 Energy Centers

PG&E, SCE and SCG operate Energy Centers. The Energy Centers are designed to educate customers about energy efficient business solutions. The Energy Centers use training, outreach, education, and tool development to support the delivery of statewide energy efficiency programs. The utilities have worked together to collaboratively build on a statewide program for the Energy Centers, including seminar/program coordination, a web-based energy efficiency library, partnership program with third parties and/or other state agencies. The Energy Centers target all nonresidential customers and all applicable end-uses, although elements of all three utilities'

Energy Centers specifically target food service equipment [???]. Each of the utilities' Energy Centers is listed below:

- PG&E – Pacific Energy Center (PEC), Food Service Technology Center (FSTC), and Energy Training Center – Stockton (ETC).
- SCE – Customer Technology Application Center (CTAC), Agricultural Technology Application Center (AGTAC).
- SCG – Energy Resource Center (ERC).

B.2.3 Emerging Technologies

PG&E, SCE, SDG&E, and SCG have set aside funding for statewide Emerging Technologies program activity. These activities focus on demonstrating energy efficiency options not widely adopted by various market actors. The Emerging Technologies Coordinating Council (ETTC) was established to seek opportunities to coordinate efforts between each of the utilities Emerging Technologies Programs, as well as the CEC's PIER Program. The utilities and the CEC continue discussions on emerging technologies through the ETTC, and are working with individual customers to develop showcase emerging technologies projects in their service territories. Results from these projects (e.g., detailed designs and performance criteria) are widely distributed.

B.2.4 Renovation and Remodeling Programs

Through the statewide Savings By Design Program, the utilities encourage high performance nonresidential building design and reconstruction practices for all nonresidential buildings undergoing remodeling and/or renovation. The following summarizes PY2001 budgets for renovation and remodeling activity by utility:

- SCE: $1,150,000
- SDG&E: $855,000
- SCG: $1,130,000
- PG&E: $1,000,000 (additional $100,000 for commissioning projects, and $1,000,000 for renovation and remodeling measures delivered through Express Efficiency).

B.2.5 Other Support Programs

Each of the utilities offers a number of programs that are designed to support the financial incentives programs (e.g., Express Efficiency, SPC). These programs include such activities as providing special services to upstream market actors such as technical assistance, incentives, etc., targeting more complex applications such as chillers or compressed air systems, and/or providing marketing and outreach support to target market segments such as hard-to-reach. The following table summarizes each utility's other program support activities and provides PY2001 budget information.

Utility	Program Name	Description	PY2001 Budget
SCE	Small/Medium Energy Management Services	Targets underserved market segments with on-site energy audits and program promotion via trade associations and community-based organizations	$350,000
	Small Nonresidential Mass Market Information	Includes distribution of English and non-English versions of the Energy Guide, and development of English and non-English "quick tips" guides, technical briefs, and energy kiosks	$1,413,000 (includes Consumer Affairs Agency's statewide media campaign)
	Space Rental Update (pilot component of Small/Medium Nonresidential SPC)	Promotes implementation of weatherization measures in strip malls and other commercial properties.	(Part of Small/Medium SPC budget)
	Commercial Energy Efficiency Information Services (EEIS)	Involves direct contact with large commercial customers to promote SCE programs (e.g., SPC, Express)	$575,000
	Industrial Energy Efficiency Information Services (EEIS)	Involves direct contact with large industrial customers to promote SCE programs (e.g., SPC, Express)	$575,000
	Beat the Peak	Targets municipalities and other large commercial/industrial customers looking for voluntary peak load reduction during State 2 and 3 alerts	(Part of Commercial and Industrial EEIS budgets)
	Agricultural/Pumping Services Program	Provides pump testing services to encourage pumping customers to adopt preventative maintenance practices that ultimately improve overall pumping system efficiency.	$2,100,000
SDG&E	Large Nonresidential Information Program	Promotes incentive programs and offers seminars targeting large nonresidential customers	$95,000
	EnVINTA One-2-Five	Offers building efficiency rating tool to large customers	$75,000
	Energy Information Center (EIC)	Uses trained reps to assist small customers with specific energy efficiency issues	$100,000
	Small Nonresidential Information Program	Promotes incentive programs and offers seminars targeting small/medium nonresidential customers	$453,000
	Small Comprehensive Technical Assistance	Provides technical consulting expertise to small/medium businesses for specific end-use retrofit applications	$150,000
	Building Operator Certification	Trains/certifies facility managers of commercial/governmental buildings	$50,000
	Small Nonresidential Commercial Horizontal Washers Program	Provides incentives for high efficiency, H-axis washing machines in apartment complexes and Laundromats	$250,000
	Small Business "EZ" Turnkey Program	Offers rebates to smallest commercial customers (peak demand less than 50 kW), with special emphasis directed to state-identified Enterprise Zones	$450,000
SCG	Comprehensive Space Conditioning Efficiency Improvement Program	Offers information, audits and incentives for efficiency improvements in gas space conditioning systems	$1,457,000
	Advanced Water Heating Systems Program	Offers information, audits and incentives for high efficiency water heating equipment	$875,000
	Integrated Food Services Equipment Retrofit Program	Provides information, audits, and financial incentives to encourage small commercial cooking customers to make energy efficiency improvements	$2,474,000
PG&E	Chiller Analysis Program (CAP)	Provides analysis of chiller/cooling systems to identify low-cost/no-cost improvements	$500,000
	Lighting System Analysis (LSA)	Provides analysis of lighting systems to identify low-cost/no-cost improvements	$1,500,000

B.2.6 Other Nonresidential Programs

SCE, SDG&E and SCG offer other nonresidential programs that do not fit in any of the above, standard nonresidential categories. These include:

- SCE Agricultural/Pumping Services Program – provides pump testing services to encourage pumping customers to adopt preventative maintenance practices that ultimately improve overall pumping system efficiency. PY2001 Budget: $2,100,000.
- SDG&E Small Nonresidential Commercial Horizontal Washers Program – provides incentives for high efficiency, H-axis washing machines in apartment complexes and laundromats. PY2001 Budget: $250,000.
- SDG&E Small Business "EZ" Turnkey Program – offers rebates to smallest commercial customers (peak demand less than 50 kW), with special emphasis directed to state-identified Enterprise Zones. PY2001 Budget: $450,000.
- SCG Integrated Food Services Equipment Retrofit Program – provides information, audits, and financial incentives to encourage small commercial cooking customers to make energy efficiency improvements. PY2001 Budget: $2,474,000.

B.3 THIRD PARTY INITIATIVES

Most of the utilities are offering programs referred to as Third Party Initiatives, or "TPIs." The strategy behind the TPIs has been to solicit innovative programs and technologies from the marketplace for delivering cost-effective energy savings and demand reductions. Most of the TPIs were initiated in 2000 and some have been extended through 2001. The following summarizes utility-specific TPIs.

Utility	Project Description	Budget
SCE	Beverage vending machine retrofits	$6,390,000 (includes all Residential, Nonresidential, and New Construction TPIs)
	Small/Medium business air conditioning retrofits	
	Commercial building commissioning	
	Hard-to-reach small business lighting retrofits and HVAC enhancements	
	Small/medium commercial lighting audits, design and retrofits	
SDG&E	Building Recommissioning TPI	$270,000
	Peak Load Reduction TPI	$1,300,000
	Retrofits in Leased Spaces TPI	$405,000
SCG	Mobile Energy Clinic	$300,000
	Lodging Education (Audits, Website)	$268,000
	Coin Laundry and Dry Cleaner Education (Workshops, Newsletter, Website))	$351,000
	High Efficiency Medium Tonnage Natural Gas Cooling Field Demonstration	$248,000
PG&E	Marketing/Outreach Support for HTR Market Segment	$2,500,000 (includes all Nonresidential TPIs)
	Audits/Installation in Oakland and Berkeley communities (Aspen)	
	Hotel Financing Project (ICF)	
	Small Business Website (DR International)	
	Engineering Support for SPC (KW Engineering)	
	Long Term Care Facility (IMT)	
	Environmental Waste Management in Restaurants (SAIC)	
	Historical Preservation (Presidio)	
	Small Business Improvements in East Palo Alto (SEI)	

B.4 SUMMER INITIATIVE PROGRAMS

Most of the utilities have also solicited TPIs as part of the Summer 2000 Initiative. These TPIs have also been solicited to deliver cost-effective energy savings and demand reductions prior to June 2001. The following summarizes the various Summer 2000 Initiative Projects.

Utility	Project Type	Project Description	Budget
SCE	Statewide Summer Initiative Programs	Campus Energy Efficiency Project	$3,500,000
		Beat the Heat	$250,000
		LED Traffic Signal Rebates	
		COPE Peak Load Reduction Program	$1,500,000
	Summer Initiative TPIs	Small/medium commercial lighting retrofits	$340,000
		Small/medium commercial HVAC retrofits (evaporative pre-coolers)	$560,000
SDG&E	Statewide Summer Initiative Programs	Campus Energy Efficiency Project	$2,000,000
		Beat the Heat	$150,000
		LED Traffic Signal Rebates	
	Summer Initiative TPIs	HID Lighting Control Project	$1,000,000
		Compressed Air Efficiency Project	
		HID Fixture Replacement Projects	
		Skylight Lighting Control Projects	
		Evaporative Pre-Cooler Project	
		Rooftop AC Repair Projects	
PG&E	Statewide Summer Initiative Programs	Beat the Heat	
		Campus Energy Efficiency Project	
		LED Traffic Signal Rebates	
		COPE Peak Load Reduction	
	Summer Initiative TPIs	Active Load Management Program	
		Commercial Building Energy Efficiency Program – Lighting	
		Commercial Building Energy Efficiency Program – Other	
		Evaporative Cooling Program	
		Industrial Refrigeration Program (Glycol Heat Transfer Fluid Optimization)	
		Industrial Refrigeration Program (Direct Expansion Valve Upgrade)	
		Office Equipment Efficiency Program	
		Vendor Coupon Program	
		Wastewater Plant Aeration System Optimization Program	
		Cool Roofs	
	Utility-Specific Projects	Energy Efficient Design Improvement, City of Oakland	
		Museum Chiller Improvement, City of Oakland	
		Energy Efficiency Measures, Humboldt Creamery	